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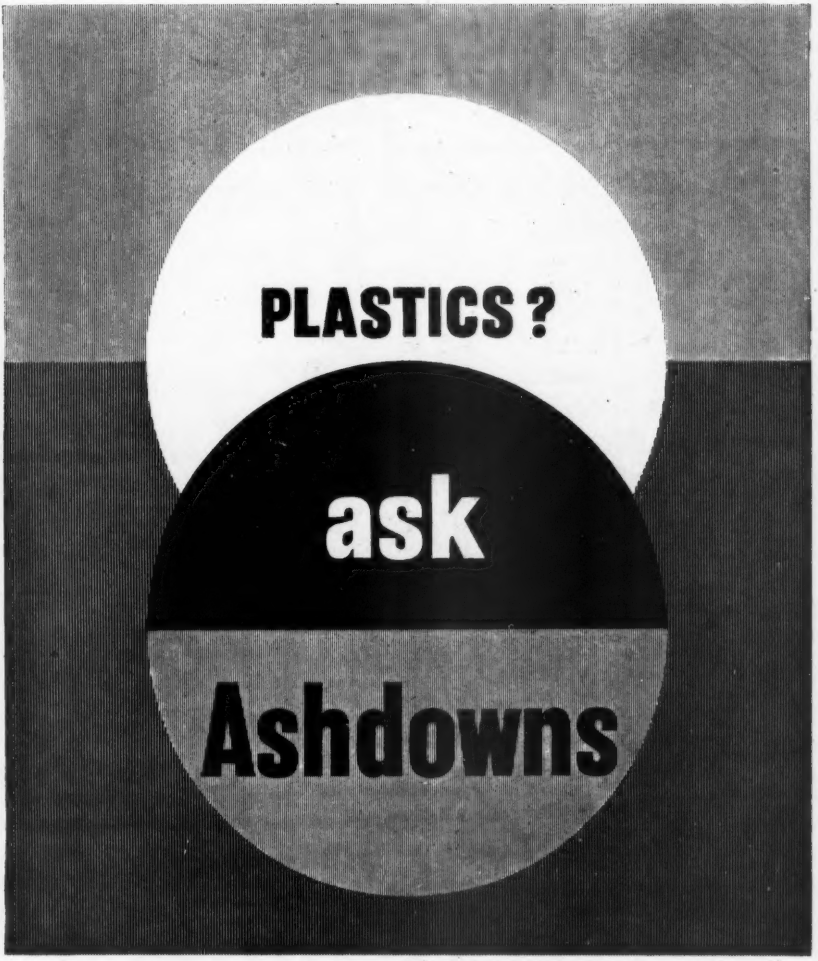

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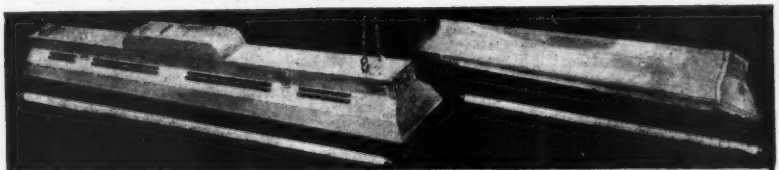

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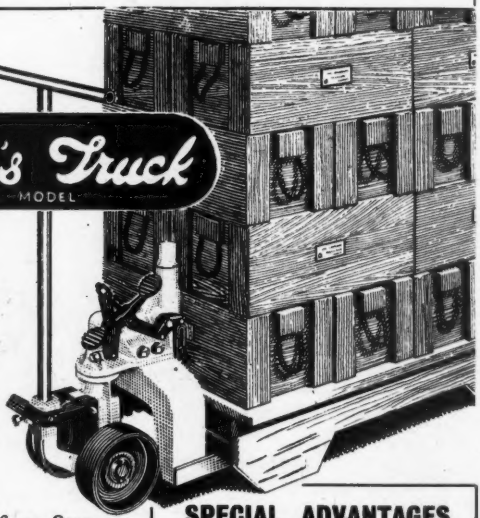

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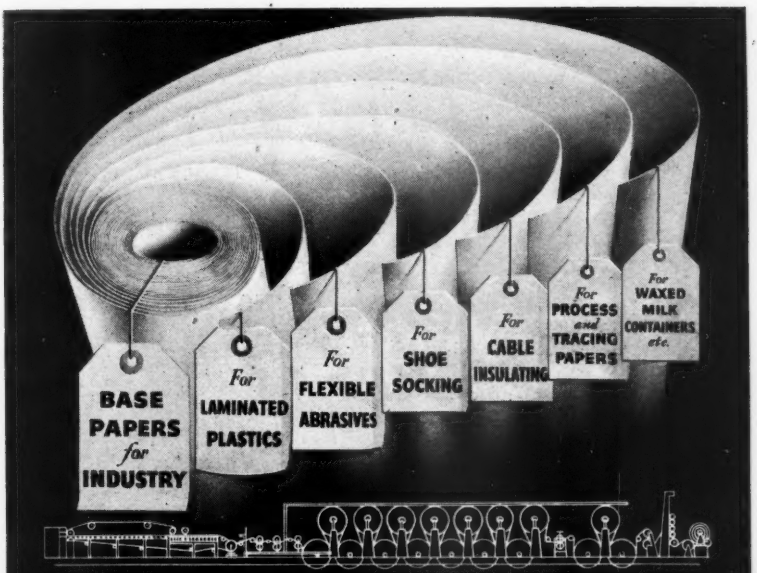

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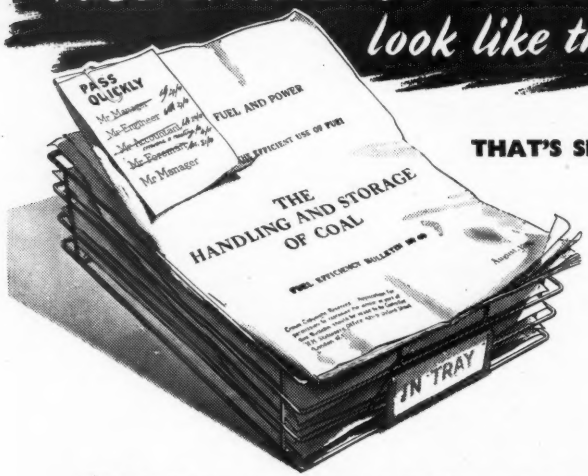

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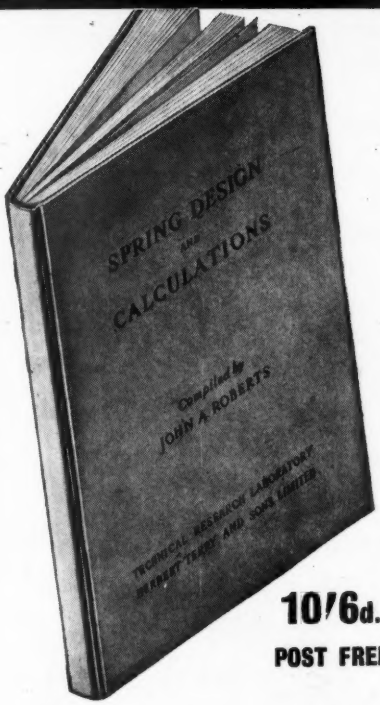

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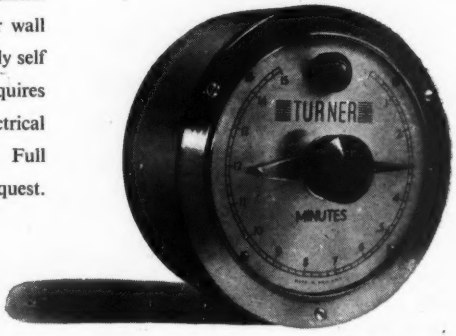

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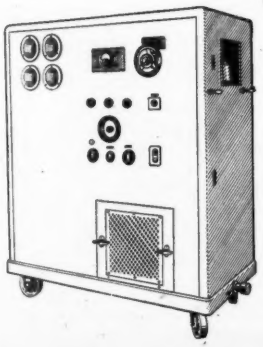

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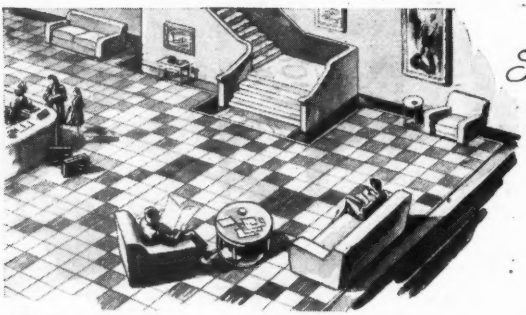

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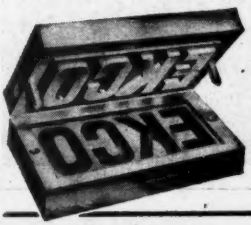

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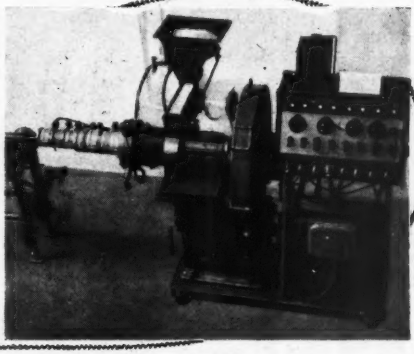

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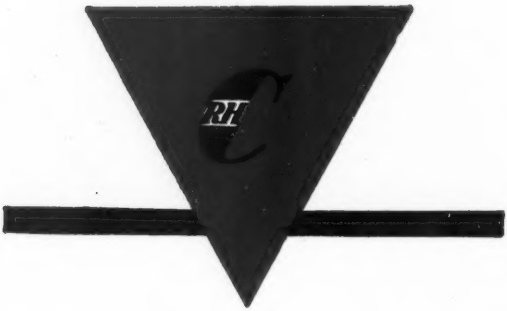

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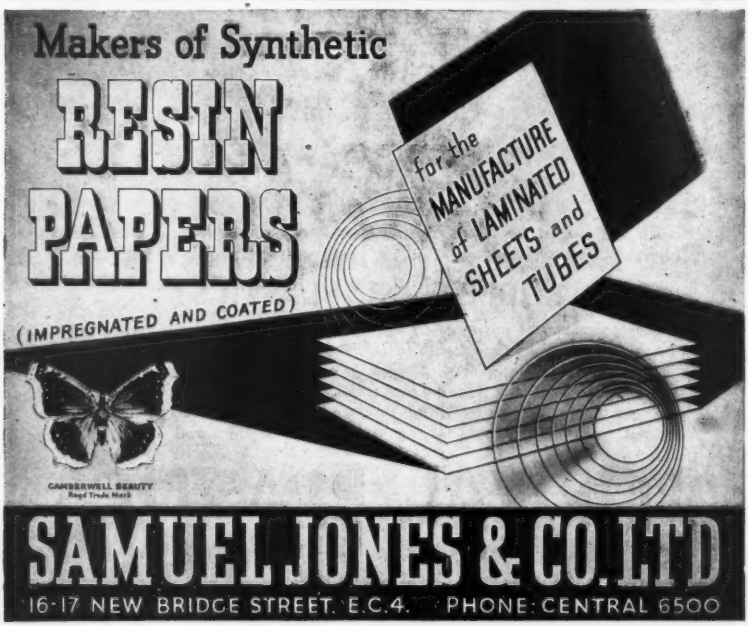
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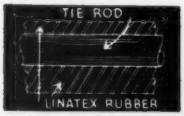

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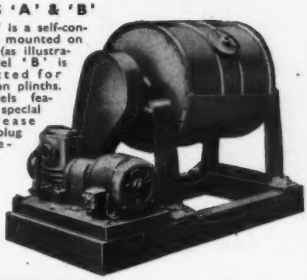
Model 'A' is a self-contained unit mounted on a bedplate (as illustration). Model 'B' is constructed for mounting on plinths. Both models feature the special quick release handhole plug which requires no spanners.



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This design permits of an inline battery of Ball Mills being accommodated. The cylinder has a detachable end plate which greatly facilitates cleaning out — an important point where a variety of substances require to be ground.

UNITS COMPLETE with motor and reduction gear, or for line shaft drive. Replacement drums supplied for existing units. Sizes 1' 0" inside dia. to 3' 6" inside dia. Speeds : to suit customers' requirements. *Ideal for Pigments, Ceramics, Graphite, Plastics, etc.*

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THE BRITISH PLASTICS FEDERATION

(LIMITED BY GUARANTEE)

WORSHIPFUL COMPANY OF HORNERS AWARDS

The Council of The British Plastics Federation, as administrators of the Worshipful Company of Horners Prize Fund, offer three prizes of the value of £15 each, for original craftsmanship for :—

1. Design for a moulding.
2. Production of a mould or die in metal, or a prototype or model mould in wood.
3. Drawing for the general arrangement of a moulding tool.

The prizes are open to employees of not less than twelve months standing with member firms of The British Plastics Federation. The Council reserves the right to restrict the number of prizes awarded if contributions should not be deemed to be of sufficiently high standard.

Entries, which must *not* bear the name of the craftsman, but which should bear a number or code letter, should be forwarded with a covering letter giving the following information:—

Name and address of the employee, with code number used.

Name of his employers and length of time he has been employed by them, with a letter from a responsible official representing his employers, giving permission for the entry to be submitted.

Entries should be sent to the General Manager, The British Plastics Federation, 47-48 Piccadilly, London, W.1, so as to reach him not later than the first post on Saturday, 24th April, 1948.

Additional copies of this advertisement can be had on application to the Federation.

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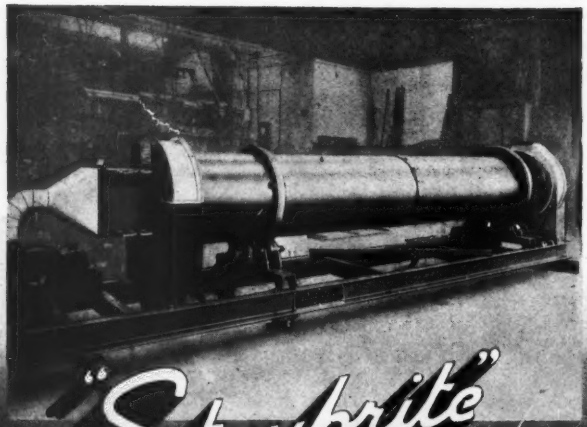

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ROTARY DRYERS FOR PLASTICS ETC.

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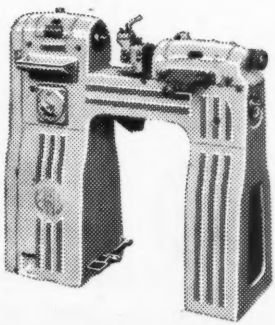

The British

ANGLON

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Our Button Manufacturers' Service is being rapidly augmented by the addition of new lines; several interesting machines will be announced shortly. Contact our Button Plant Division for full details of the E. H. J. Service.

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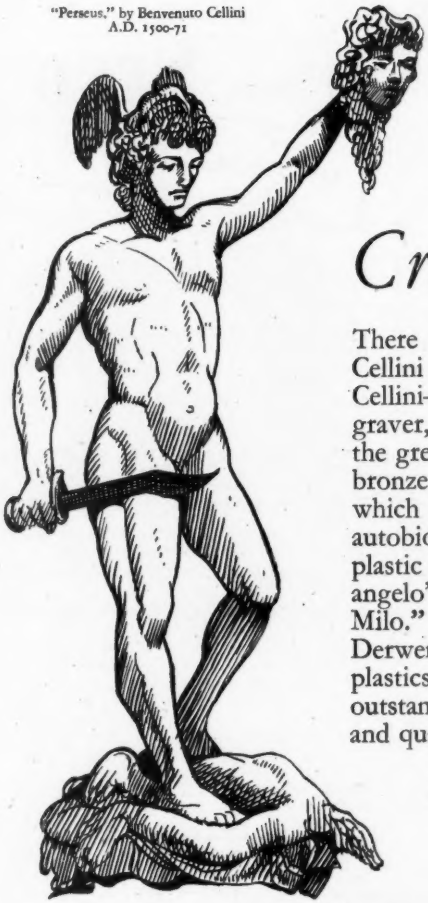

"Perseus," by Benvenuto Cellini
A.D. 1500-71

Craftsmanship

There is a distinct parallel between Cellini and Derwent Plastics Ltd. Cellini—16th-century sculptor, engraver, goldsmith, soldier—was one of the greatest craftsmen of all time. His bronze "Perseus," the moulding of which is graphically described in his autobiography, is a masterpiece of plastic art; comparable with Michelangelo's "David" and the "Venus de Milo."

Derwent Plastics, too, are craftsmen in plastics whose moulded products are outstanding for their accuracy, finish and quality.

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MINSTER MOULDINGS

DERWENT PLASTICS LIMITED

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our sort of plastics

Even to the technically minded buyer, plastics are confusing. So many materials of different chemical origin, so many methods of using them — all included under this rather vague family name.

But there is nothing vague about our organisation at Tyburn. We make *moulded* plastic components in large quantities for the electrical and engineering industries, and we design and make the steel moulds that produce them.

We have nothing to sell to you over the counter — what we offer is a manufacturing service, the ability to design and produce plastic mouldings to satisfy your particular needs. Just now our mould making shop is heavily loaded and our supplies of moulding powder are far from adequate, but we can plan for better days ahead.

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MOULDED PRODUCTS LTD. . . *Birmingham*

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M P. 101

If you NEED HYDRAULIC PRESSES *we have*

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2,000-ton DOWNSTROKE HYDRAULIC PRESS by Fielding & Platt, Ltd., table 5' square, fully guided, ram 29" diameter, daylight 7', with intensifier.

1,500-ton FIELDING & PLATT DOWNSTROKE DIE FORGING PRESS, table 5' square, with self-contained Pumping Equipment.

1,000-ton DOWNSTROKE HYDRAULIC PRESS by Rice & Co. Ltd., table 6' x 4', 23" ram, 6' daylight, with Ejectors and Intensifier and Accumulator and Three Throw Hydraulic Pump.

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RODS
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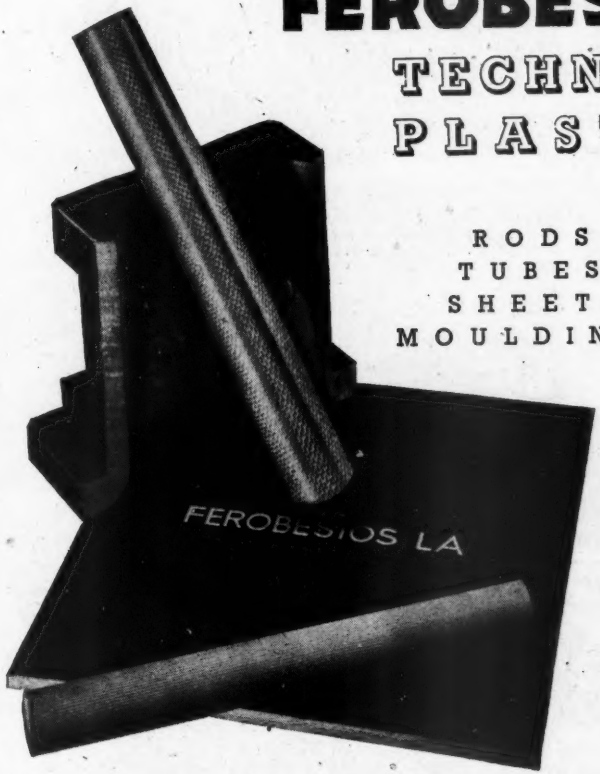

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If you require

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- Low moisture absorption.
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"NEVER SATISFIED THAT A PERFECT *MIX* HAD BEEN OBTAINED *until....*

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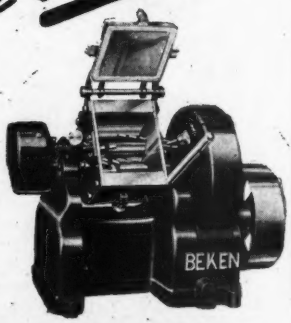

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UP TO 30 INCH WIDTH

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WORKS · GUERNSEY ROAD, SHEFFIELD
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Trapinex Paint Printing Processes employ the special advantages which *paint* has over printers' ink—greater brilliance of colour, durability, washability, resistance to rain, frost and strong light. These advantages are common to the process of direct printing in our works on to flat sheets of plastics, metal, glass, wood, etc., or to the "Trapinex" Paint Printed Transfers applied in your works by unskilled labour to made up articles, equipment, machinery, drums, bottles, display stands, etc., and, of course, for shop-window advertising.

Advice freely given, but when you write for prices please state: (1) Size. (2) Quantity. (3) Number of colours. (4) Purpose. (5) Wording required. (6) A rough sketch would help. ***We have no stock lines or price lists.***

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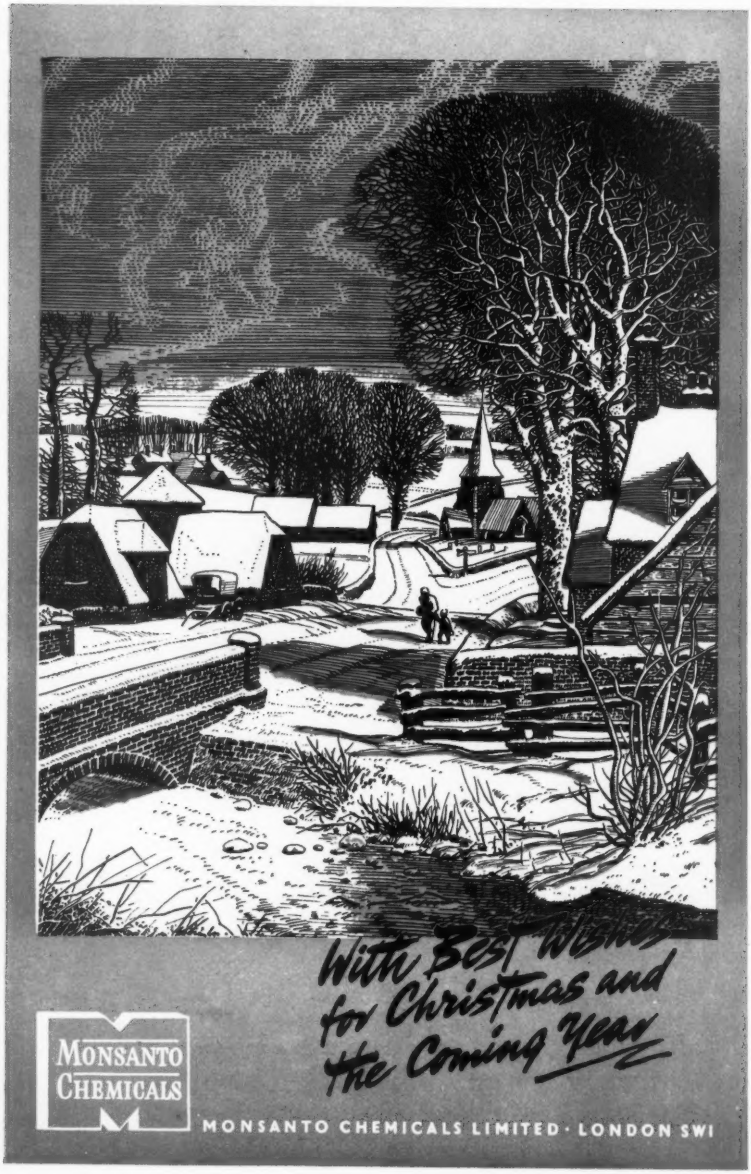
With Best Wishes
for Christmas and
the Coming Year
MONSANTO
CHEMICALS
MONSANTO CHEMICALS LIMITED · LONDON SWI

Vol. XI. No. 127 DECEMBER, 1947

Plastics

Dealing with the Manufacture, Uses and Potentialities of Plastic Materials

Proprietors - - TEMPLE PRESS LIMITED
Managing Director - ROLAND E. DANGERFIELD

Editor - - M. D. CURWEN, B.Sc., A.R.I.C.
Offices - Bowling Green Lane, London, E.C.1

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NOTICES

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EDITORIALS

Our Raw Materials

YET another step, momentous to this country, has been taken towards the goal of creating here a new chemical industry from petroleum. Our recent disclosure of the trend of manufacture by the "Shell" group is now confirmed. The news last month gives details of proposed new "Shell" capital for, amongst other projects, the erection of two new refineries, one on the Thames and the other on the Manchester Ship Canal. Ten million pounds is to be raised, much of the plant being needed for the production of new chemicals.

Thus we see taking shape a condition we have hoped for since 1925, when we watched the beginnings of the American "chemicals-from-petroleum" industry. Then, in another journal, we informed those who would read, that the U.S.A. would thus usurp Germany's and Gt. Britain's positions as the giants of the world's chemical industries. Ten years later British production in certain chemicals of the solvent type was killed stone-dead, and we were importing new ones that had never seen the light of day.

In a few years we may regain much lost ground because of the "Shell" and of other decisions. It is true that we are producing a few well-known chemicals from petroleum already, but the range and quantities of solvents and, indeed, of raw materials for the plastics industry now possible are so numerous and great as to make all previous production appear puny by comparison.

Thus, from this source alone, presuming we shall see large-scale production of unsaturated gases, ethylene, propylene and butylene will be available not only for making polymers, but also the production of new chemicals for new resins.

There is yet another branch of petroleum technology that we have already described in these pages, namely, that employed by Petrocarbon, Ltd., also with a factory in process of erection. Here, by a remarkable feat of chemical juggling, will be produced, also from petroleum, benzole and similar compounds which to date we have only succeeded in obtaining from coal. This transformation will provide us with phenol, styrene and, perhaps, even resorcinol and other similar compounds for the newer plastics.

Yet another section of our raw materials is now being derived from the Distillers Co.'s carbide factory at Port Talbot, erected during the war for solvent production and now turned over to making polyvinyl compounds from acetylene.

At last we are seeing a more complete picture of our future chemical world, and all we can hope for now is that the Government will see the necessity for this urgent new construction and that it sees that the chemical industry is one of the lynch-pins of our industrial wheels. Without it neither aircraft production nor shipbuilding nor motorcar manufacture, nor agriculture, nor plastics, nor steelmaking, nor anything could be carried on in a modern way.

The coal situation and other inadequacies, and the tremendous demand, has affected plastics more than we realize at a casual glance. Shortage of coal has not only affected us obviously by quantity shortage of phenolic and urea resins, and perhaps polyvinyl compounds, but has also resulted in the lowering of quality, so that in some cases the standards laid down have no longer their full meaning. We can also readily see how shortage of phenol, for example, could cut nylon production, which starts with phenol, and, again, could affect the appearance of

new materials, such as the plastic "Terylene," our new British fibre.

On the whole, in spite of our present difficulties, the future of our industry is, because of these new ventures, very bright indeed. In a few years, with the plants in full swing, we shall have enough for all our needs and perhaps enough intermediate chemicals over to export. It should make this the greatest chemical-producing country outside the Americas.

If the Government needs a statistical comparison to put plastics (or any chemical production, for that matter) into its proper place purely as a potential money maker and as an efficient entity, we have now available the enlightening figures given by Dr. Worboys, of I.C.I. Plastics Division, in his paper entitled "The Plastics Industry—Its Material Requirements," which he read this year before the Plastics Group of the Society of Chemical Industry. These figures are as follow, and in the case of the plastics industry and agriculture are approximate.

	Value £s.	No. of Workers.
Coal ..	400,000,000	700,000
Agriculture	500,000,000	1,000,000
Plastics ..	60,000,000	60,000

Dr. Worboys's figures for the value of finished plastics at £60,000,000 appear to us quite low, but, even so, would give us a ratio of value of output per worker in the three industries indicated as: Plastics, £1,000; Coal, £570; Agriculture, £500.

If these figures do nothing else, they probably have some bearing on the relative efficiencies of the industries. From a quantity-production point of view we are well behind coal and agriculture, but the plastics industry is at least forging ahead rapidly. We can scarcely accuse coal or agriculture of rapid progress.

Let us Learn and Live

TOWARDS the end of 1943 we were able to examine a secret document compiled by an Australian scientific commission, on the deterioration of service material under tropical conditions in New Guinea during the opening year of the war against the Japanese. The story was a grim one, for while the Australians, as ever, could more than hold their own against the enemy as men, they had a continual and sometimes losing battle against climate, insects, fungi and bacteria. It did not make pleasant reading to learn, quite apart from casualties due to disease, that boots and boats, rifles and aircraft parts, radio equipment and microscopes, clothing and tenting were often rendered useless before they had reached the front line—this after workers in factories far away had sweated blood to turn out the goods in quick time.

We took a great interest in the problem, we saw some facts of the appalling difficulties in overcoming it and indeed gave some suggestions on one aspect. Suffice it to say that research on a big scale was launched and specifications for many types of protection against humidity, insects and the rest were laid down and applied. Almost every finished object, every sheet of wrapping paper and every packing case was treated to ensure that the soldier in the jungle at least received his weapons, his clothes, his medicines and his means of transport in a condition which allowed him to fight.

In 1944 the Ministry of Supply here published an excellent booklet, describing the problem and the means that were adopted to combat it. Of all things in this uncertain world we are certain of one —that the time and money spent on this research was worth while and that the job carried out was a fine one which saved many lives and possibly, many battles.

Obviously, electrical equipment, because of its greater sensitivity to humidity and concomitant fungal growth, received especial consideration and a careful directive was issued incorporating latest designs and impregnating compounds such as varnishes based on the most efficient synthetic resins we could produce. These methods decreased the incidence of failure to relatively negligible proportions.

Judge our shock, therefore, at receiving

from Mr. C. R. Pye, to our own knowledge, an expert in such protection of electrical equipment, the letter we reproduce on page 651. At the recent Radiolympia where all the famous manufacturers of wireless equipment show their products to the world, he found that many units such as transformers and chokes were in an unimpregnated condition.

Even in this country we should insist that our equipment be given adequate protection. If, as one must assume, such units are exported to Australia and New Zealand, they may find their way to New Guinea, the very country in which experience caused the whole question to be raised!

We cannot afford to jeopardise this important section of our export trade anywhere, much less in the tropical Commonwealth or in Africa or tropical America. We trust that this matter will be at once examined by Authority in the radio-equipment industry.

Means for Quality Control

A STEADY increase in the use of quality control is being found in industries hitherto unaffected. The reason for this is that the wisest among manufacturing concerns are realizing more fully that they cannot acquire and continue to hold a fair part of the existing markets for their goods in the absence of maintaining a desirable standard in production. In a recent editorial we have already expressed our own particular thoughts upon quality goods, in so far as we are interested in manufactures using materials of the plastics industry. There is, however, another aspect upon which it is opportune to offer comment. It concerns those means which are available for maintaining quality in production, assuming there is a desire on the part of the manufacturer to produce goods which will do him credit.

This aspect of the case for quality goods has been fostered particularly by the British Standards Institution, in conjunction with various professional engineering bodies. Even in the industries themselves there have long been those concerns who have realized that quality control is a matter of importance in the preparation of specifications for goods, and, indeed, may be the only satisfactory basis for a specification, irrespective of whether goods are intended for the home market or for export. The attention which the British Standards Institution have focused on this subject has confirmed the views which have been expressed in other directions.

Already an increasing number of British Standards refer to quality control in their acceptance clauses. Following this a need has arisen for books which describe the available methods, and doing so without any serious reference to statistical principles or the mathematics which are involved. The first of such publications which has come into our hands in readable form is a new British Standard (B.S. 1313), which describes the simplest and cheapest form of quality control, namely, that attained by the aid of charts for examining that fraction which is defective in samples of goods under production. Herein are set out the accepted methods which are easy to use, and which, moreover, can satisfactorily and profitably replace examination of manufactured goods to the full degree of 100 per cent.

The new standard for "Fraction-defective Charts" shows clearly that the methods described are capable of wide application, not only in the actual factories but can also find use in warehouses, and even in the large shops and stores where the goods are sold. Every method described in this new standard is covered by examples of usage from actual practice, and even a cursory examination of the many charts which are reproduced will prove enlightening to all who have an honest interest in the quality of the goods they are making and desire to sell.

Our readers will be interested to note that with this issue we begin publication of a new series by Mr. Halliday, entitled "Quality Control," which deals more specifically with our own problems.

Synthetic Enamels for Insulation of Copper Wire

By C. R. PYE,* B.Sc., F.R.I.C.

THE insulation of winding wire by a continuous film of an insulant, as opposed to the discontinuity of fibrous insulation such as cotton, silk, etc., has now been almost universally adopted, due to the improvement shown in breakdown potential, volume resistivity, resistance to humid conditions, mechanical properties, and, above all, the thinness of coating with which the above improvements can be obtained. This latter factor implies that the same characteristics can be obtained in a much smaller coil wound with enamelled copper wire than with the older fibrous insulation; this is becoming increasingly important in these days of economy of design, where the tendency is towards smaller and lighter equipment with the minimum of space between components. As an example, the use of enamelled copper wire in the winding of transformers, chokes, and other components, has played no small part in the success of the designer of miniature radio equipment.

The first successful copper-wire enamels were based on oleo-resinous varnishes and typical formulæ have been given by Kienle and Adams.[1] Subsequent to the publication of this paper there were many improvements in the enamels used, but the compositions were usually jealously guarded secrets of the enamelled wire manufacturers, for it is an interesting fact that the majority of the enamel for copper wire was produced by the enamellers themselves, and not by commercial varnish manufacturers.

In 1938 Hoekstra[2] published a comprehensive review of the properties and advantages to be gained by the use of enamelled copper wire. The information contained in this paper was based on the use of oleo-resinous wire enamels which are usually baked at temperatures of 350-400 degrees C. During the course of Hoekstra's discussion he states that the resistance to impregnating materials and lacquers is extremely satisfactory, and that failures may be ascribed to the use of unsuitable raw materials in the enamel, i.e., poor formulation of the enamel. Whilst this may have been a substantially true statement at that date, when impregnating varnishes were almost wholly of the oleo-resinous types in which aliphatic hydrocarbons of the white spirit type were used as solvents, modern requirements of insulation, and developments in the use of synthetic resin-based impregnating varnishes, hardening by polymerization and/or condensation without the necessity for oxidation, have rather changed the situation.

By the use of these modern synthetic impregnants based on, for example, urea and melamine formaldehyde etherified resins, it is possible to get an extremely high degree of moisture resistance allied to a short baking period, and there is never any danger that even the deepest coil will not harden throughout, and hence the possibility of "throwing" is eliminated. In addition, the heat resistance of films of this type of varnish is superior to that of the oleo-resinous type, with the result that overloading of a component is much less likely to cause premature breakdown.

Unfortunately these obvious advantages are allied to the fact that in the majority of cases the solvents necessary for dilution of the varnishes are those with high solvent powers, e.g., aromatic hydrocarbons such as benzene, toluene, xylene, etc., usually allied to primary alcohols, such as butyl alcohol. These solvents, and, in particular, the combinations, have an exceptionally serious effect on oleo-

* Indestructible Paint Co., Ltd.

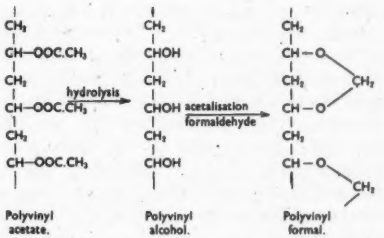
resinous films, and even the highly oxidized polymer complex of the baked enamel film on the best enamelled copper wire is rapidly softened by immersion in them, particularly at elevated temperatures.

This does not mean, however, that it is impossible to use these varnishes for impregnation of coils wound with conventional enamelled copper wire, for, provided the correct precautions are taken, a highly satisfactory impregnated component can be produced, and many of the leading firms in the electrical industry are using these processes regularly. It is desirable, however, in any technico-commercial industry to eliminate completely all possibilities of failure, and the commercial development in very recent years of linear high polymers with extraordinary solvent resistance has given the enamelled wire manufacturers the necessary raw materials to enable them to produce insulated winding wire, which is unaffected by the most modern impregnating varnishes, and, in addition, has mechanical properties giving even greater latitude in winding conditions than oleoresinous enamelled wire.

Enamels Based on Polyvinyl Ethers

The fact that these new high polymers are linear and of high solvent resistance implies that there are two main difficulties to be overcome in the formulation from them of compositions suitable for application to copper wire in a film thin enough to retain the advantages in space factor shown by enamelling. First, the polymers, being linear, are of the thermoplastic class, and hence, unless suitably modified, the heat resistance of the coating will be severely limited; secondly, the high solvent resistance implies that there is difficulty in choosing suitable solvents from which to apply the coating, extrusion of such thin films obviously being an impracticable proposition. The two major polymers on which commercially successful synthetic wire enamels have been based are: (a) polyvinyl ethers, and (b) superpolyamides ("nylon"). It is proposed in the remainder of this paper to review some of the published methods by which the above difficulties are claimed to be overcome.

The enamels based on polyvinyl ethers have been marketed commercially as applied coatings under the trade names "Formex," "Lewmex," "Duroflex," etc., and are based principally, on the formal, i.e., the ether produced by the action of formaldehyde on the alcohol. Less satisfactory results have been obtained with higher ethers, such as the acetal, butyral, etc., where the pendant ether grouping is of a larger size. The usual method of production of the resins is from the polyesters—principally the acetate—by hydrolysis, and subsequent or simultaneous acetalization by the desired aldehyde, the reactions being as shown below:—



A recently published monograph[3] has given a very good survey of the methods of production, uses and the effects of the various factors such as molecular weight of the ester, degree of acetalization, identity of the aldehyde, etc., on the properties of the final ether.

By virtue of the fact that during the process there is a production of the primary polyalcohol, a proportion of which always remains in the final acetal, this latter polymer has a tendency to be susceptible to moisture, and this seems to be the biggest defect in enamelled copper wire insulated with enamels based on these resins. The electrical strength of the film in dry conditions is excellent, but in moist conditions it depreciates to a considerably greater extent than does oleoresinous enamel. The formal is particularly subject to this defect—more so than

the higher ethers—and Llander,[4] whilst agreeing that the presence of free hydroxy groups is a contributory cause, also states that the method of acetalization is a very important factor in its effect on this property.

The principal developments in the use of this type of resin in wire enamels have been in U.S.A. and Canada, where almost the whole of the world production of polyvinyl ethers is concentrated. It is understood that there is a small production in France by Société Rhone-Poulenc (Rhovinals) and Société Nobel Francaise (Revyls), and it is known that the enamels are being manufactured and used in Switzerland, although whether produced from American or French resins is not published. The first announcement of the use and properties of wire enamels of this type was made in 1939 by Patnode[5] and co-workers of the G.E.C. Laboratories in U.S.A.

Schenectady Varnish Co.[6] have claimed the use of a phenolic compound or a chlorinated diphenyl as an agent suitable for controlling viscosity in a varnish based on this type of resin, the agent being in such a proportion that in the initial baking stages—baking being carried out at 500-900 degrees F.—the coating flows so as to produce an even thickness of film. Amongst suitable phenolic bodies are m- and p-cresol 5 degrees, 1, 2, 4-xylenol, cashew nutshell liquid, etc., and solvents for producing a workable viscosity include dioxan, coal-tar naphtha and aniline. Compatibility of the polyvinyl resin with aliphatic solvents is increased by the use of these agents. Certain of the additions actually react with the polyvinyl resin during the baking of the varnish with a consequent improvement in the properties of the film. Ratio of the addition varies between 1 of resin to 0.1 of agent, and 1 of resin to 9 of agent.

The same company[7] have also used a copolymer of polyvinyl chloride and acetate of molecular weight greater than 10,000 in 14-18 per cent. solution in a high boiling (greater than 212 degrees F.) solvent. The coating has a softening point in excess of 100 degrees C. and has been aged at 100 degrees C. for 5-6 months without change. The baking of this coating is said to be possible at less than 500 degrees F. Du Pont, in a patent[8] mainly concerned with the production of a polyester using Petrex acids and polyalcohols such as diethylene glycol, have noted a wire enamel comprising equal parts of polyvinyl formal and a solution in furfural of an ester of Petrex acids, with diethylene glycol dissolved in 10 parts of furfural.

A further modification to reduce the thermoplasticity of the polyvinyl resin has been proposed by British Insulated Cables,[9] using a melamine formaldehyde resin. A typical enamel which bakes at 350-430 degrees C. has the following composition. Melamine formaldehyde resin 6, polyvinyl acetal 14, pine oil 5, ethyl lactate 20, xylene 40 and coal-tar naphtha 15. The varnish is produced by refluxing the resins in 20 per cent. of the solvents at 90 degrees C. Resins produced by acetalization, particularly with acraldehyde or furfural, of copolymers of a vinyl organic ester, an organic ether containing a $CH_2=C<$ grouping, and at least one other polymerizable ethenoid grouping such as divinyl ether

$$CH_2=CH-O-CH=CH_2$$

are dissolved in dioxan, furfural, ketones and alcohols to produce good wire enamels.[10] The higher the degree of acetalization the superior the properties of the enamel.

The same company have also claimed[11] that acetalization simultaneously carried out with hydrolysis of a vinyl ester and an organic nitrile containing one or more vinyl groupings (e.g., acrylonitrile) gives a resin suitable for use as the base of a wire enamel. The nitrile should be in a lesser percentage than 30 and the use of furfural as the acetalizing agent gives improved solvent resistance to the resin. A similar patent[12] claims the acetal of a copolymer of one or more vinyl organic esters with a minor proportion of one or more $\alpha\ \beta$ unsaturated alky resins, e.g., glycol maleate.

Pirelli-General Cable Works have

used[13] a copolymer of vinyl chloride and acetate of molecular weight not less than 10-12,000 containing not less than 90 per cent. (preferably 95 per cent.) of vinyl chloride dispersed in four times its weight of furfural. Copper wire is passed through the composition at a temperature in excess of 40 degrees C., and the coated wire is heated to a temperature above the boiling point of furfural, and is finally baked at about 300 degrees C. A further patent[14] is a mixture of a polyvinyl copolymer and 2-15 per cent. (4-8 per cent.) of a urea or melamine formaldehyde resin, and the authors of this latter patent have also claimed[15] the use of 2-10 per cent. (4-8 per cent.) of a heat-hardening alkyl substituted or polynuclear phenol aldehyde resin in combination with a polyvinyl copolymer.

A two-coat process claimed[16] by the same company uses a first coating baked at 270-320 degrees C., comprising polyvinyl acetal 10.7, phenol formaldehyde resin 4.8, cresylic acid 22, and coal tar naphtha 62.5. The second coating is baked at 310 degrees C. for 36 seconds, and consists of superpolyamide 18.5, phenol formaldehyde 3.7, cresylic acid 77.8.

Du Pont also use[17] a polyvinyl acetal resin containing free hydroxyl groups in combination with a urea formaldehyde resin. A further mixture[18] is a co-condensate of 0.4-5 per cent. of a polyvinyl and a phenol with formaldehyde. A similar patent using an A. stage cresylic resin, a melamine formaldehyde condensate and a polyvinyl acetal dissolved in a solvent which may be partly or wholly cresol was granted to British Insulated Cables.[19].

Du Pont have also claimed[20] a compounding of a polyvinyl acetal or ketal where the aldehyde or ketone contains not more than 8 carbon atoms, and with a hydroxyl number of 60-275 (preferably 121-165) with a lower alkyl or aralkyl ether of urea, e.g., dimethylol urea to the extent of 1-100 per cent. (preferably 3-40) of the vinyl polymer. Solutions of a vinyl copolymer[21] or acetal[22] in a nitro paraffin containing more than one carbon atom, e.g., 2 nitro propane, etc., which may be further plasticized, have been noted by C. Bogin of Commercial Solvents.

In a series of patents[23] G. F. D'Alelio, of General Electric Co. (U.S.A.), has proposed various polyvinyl acetals, copolymers and modifications to same as suitable for wire enamelling. Amongst the materials used are (a) copolymers of vinyl acetate and di-isobutylene oxide hydrolysed and acetalized with propaldehyde, (b) copolymers of vinyl acetate and allyl phthalate hydrolysed and acetalized with formaldehyde, (c) acetals of hydrolysed copolymers of vinyl esters and unsaturated ketones with at least one vinyl grouping, (d) acetals of hydrolysed copolymers of vinyl esters and unsaturated alkyds, e.g., maleic alkyds, (e) acetals of hydrolysed copolymers of vinyl esters and nitriles with at least one vinyl grouping, (f) acetals using propaldehyde of polymerized di-allyladipate, succinate or oxalate, and (g) hydrolysed copolymer of vinyl acetate and divinyl ketone where acetalized to 50 per cent. of the hydroxyl content with butaldehyde.

The solution of a hydrolysed polyvinyl ester in an aldehyde, preferably furfural, has been used[24] as a coating medium for wires. Presumably the acetalization is supposed to take place during the baking of the enamel on the wire, but one would suspect that this particular coating would be very susceptible to moisture. The same company stabilizes[25] vinyl resins by addition of 0.1-2 per cent. of a phenol, naphthol or amine for use in wire enamels.

A recent publication from the laboratories of the General Electric Co. (U.S.A.)[26] has discussed the effect of solvents on enamelled copper wire of the Formex type. Amongst solvents which do not affect the wire at all are acetone, butyl acetate, cyclohexanol, cyclohexanone, di-acetin, ethyl alcohol, ethyl acetate, ethylene dichloride, ether, 100-octane petrol, phenol; whilst amongst those which soften it to the finger tail test are aniline, benzene, chloroform, cresol, methylene dichloride, dioxan, furfuryl alcohol, furfural, methyl ethyl ketone, nitro benzene, nitro methane, 1 and 2

nitro propanes, toluene, and various mixtures of these solvents.

Enamels Based on Superpolyamides

The use of superpolyamides (nylons) as the basis of enamel media for enamelling copper wire is of even more recent commercial interest than polyvinyl ether. The first publication of a comparison of the properties of wire enamelled with a nylon coating and an oleo-resinous enamelled wire was given by Gee and Cowen,[27] who showed that the coating was unaffected by the majority of solvents, although alcohol, phenols and cresols would soften it. The abrasion, flexibility and general mechanical properties of the enamelled wire were very good, and ageing properties considerably in excess of those of oleo-resinous enamelled wire. The electrical properties, however, were not so good as oleo-resinous enamels from the aspect of dielectric strength, and in order to obtain the same degree of insulation resistance it was necessary to apply a coating slightly over 1½ times the thickness of oleo-resinous enamel.

This point means that although the space factor is still better than fibrous coverings, it is not so good as oleo-resinous enamels. The enamel on which these results were obtained was one in which the nylon had been modified with a thermosetting resin. One further drawback of the nylon type of enamelled wire is that the adhesion of the coating to the wire is not of the same order as oleo-resinous enamel, and the coating is liable to be removable from the wire as a sleeve.

Du Pont[28] state that coatings of certain polyamides from solution in a mixed solvent of alcohols and hologenated hydrocarbons at elevated temperatures can be dried at 90 degrees C. Such a solution giving an intrinsic viscosity of 1.07 at 55 degrees C. (the coating temperature) is obtained by the use of 10 parts of 50/50 (molecular proportions) mixture of hexamethylene adipamide and decamethylene sebacamide in 90 parts of chloroform, 2.4 parts of methyl alcohol and 6.5 parts of butyl alcohol.

A patent[29] emanating from the laboratories of the General Electric Co. (U.S.A.) quotes a mixture of hexamethylene adipamide with 10-40 per cent. (preferably 33) of dewaxed shellac in solution in a mixture of cresol 4 parts and coal-tar naphtha 1 part, the solid content of the varnish being 20 per cent. This coating can be applied to the wire such that six coats give 0.0036-in. coating on 0.032-in. diameter wire and is baked at about 330 degrees C. until black. One interesting point about this particular coating is the claim that a longer baking period improves the elasticity of the coating, and that a running speed of 16 ft. per minute at 330 degrees C. will allow an elongation of the wire of 30 per cent. without the appearance of cracks, and gives a dielectric strength of 3,000 volts per mil.

(To be continued.)

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(10) *B.T.H., B.P.* 552,313. (11) *Idem, B.P.* 554,121. (12) *Idem, B.P.* 557,159. (13) *Pirelli General Cable Works and H. Barron, B.P.* 561,514. (14) *Du Pont and H. G. Stauffer, B.P.* 565,707. (15) *Du Pont and H. F. Ether, B.P.* 566,109. (16) *Du Pont, B.P.* 570,226. (17) *Idem, B.P.* 572,206. (18) *Scott Bader and H. C. Bryson, B.P.* 573,437. (19) *British Insulated Cables, Ltd. and J. F. Cowen, B.P.* 578,882.

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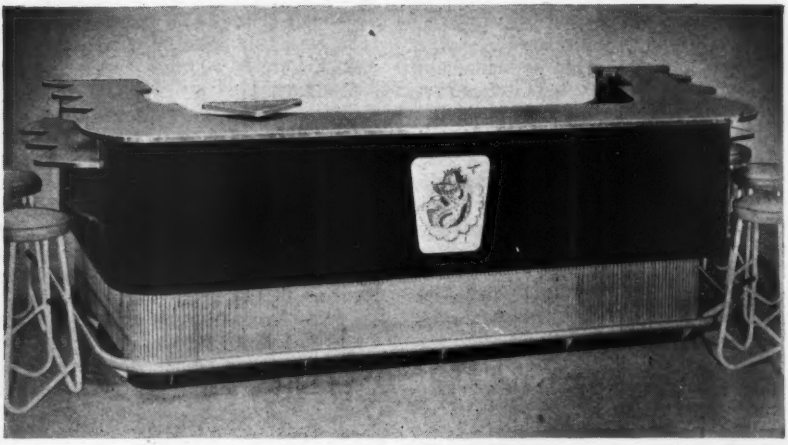
Seen at the Brewers' Exhibition



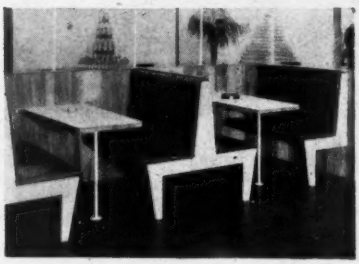
This bar, from a design by Mr. H. N. James, L.S.I.A., was featured at the recent Brewers' Exhibition, at Olympia, in London, by De La Rue Insulation, Ltd. It is of "Traffolyte," with the counter surfaces of cigarette-proof "Formica" with linette and realwood finish. The inlay upon the front panel, representing Old King Cole, is actually bonded in "Traffolyte." The bar was fabricated by Hampton and Son, Ltd.

Illustrated to right is the general view of a bar executed in "Formica," by Gaskell and Chambers (London), Ltd. Three murals painted by Myerscough Walker, using synthetic-resin paints upon sizeless paper, have been incorporated as surface laminations in sheets of "Formica."

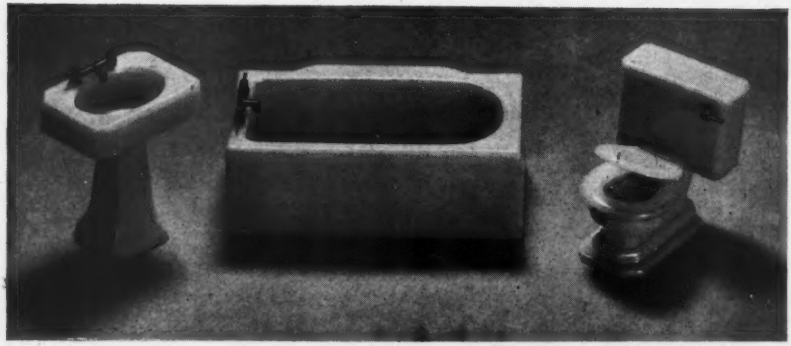
The office desk (left) has the interesting feature of a recess for the telephone, the cord passing through one of the tubular legs. Designed by Mr. H. N. James, the horizontal surfaces are in cigarette-proof grades of "Formica" realwood.

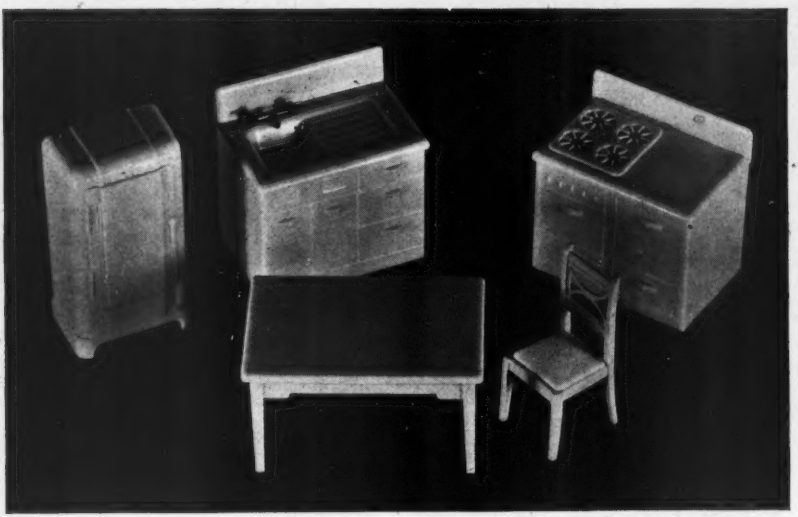
This very striking design for a cocktail bar, by Mr. Richard Levin, M.S.I.A., is executed in "Warerite" laminated plastics (Warerite, Ltd.). The fearsome dragon is colourful in green, red, black and gold, being an original watercolour which is permanently incorporated in the plastic sheet. The same technique is adopted for the Chinese motif seen upon the wall in the background. The general colour scheme of the bar is dove-grey, with maroon top and footings.

The new design of radiogram by E. K. Cole, Ltd. (right), also employs "Warerite" laminated plastics for decorative treatment of the cabinet. The colour scheme is grey and cream.



Laminated plastics incorporating the grain of birchwood are used for the dining alcove (left), which was part of the exhibit by Warerite, Ltd. Tables are of cream "Warerite" with birchwood edging; upholstery is a vinyl material made from "Vybak" compounds.





Toy furnishings for the doll's house have taken on a new aspect with the production of these bathroom and kitchen features, which are injection moulded in cellulose acetate by O. and M. Kleemann, Ltd. The bath is 4 ins. long. Injection moulded polystyrene is also being used for articles in this new range of toys.

CAVALCADE

These delightful and beautifully designed toy Hussars have been on sale in this country for some short time, and are now available for export. We heartily congratulate the moulders on this reproduction which is so full of fine detail and "movement." The horses are produced by injection moulding "tail to tail."

(With acknowledgments to the designers and moulders, Fraser and Glass, Ltd., Assembly Works, Woodside Lane, Finchley, London, N.12.)

The Repair of Ebonite Accumulator Boxes

EBONITE accumulator boxes which have become unusable owing to the appearance of cracks or fractures can be repaired by hot gas welding. The process is described by W. Schrader in "Autogene Metallbearbeitung," 1944/**37**/209.

The cracks (Fig. 1) should be cut out with a carborundum wheel, and the grinding operation being continued so that the ground part exceeds the length of the crack on each side by about 5 mm. Wheels, working at a speed of at least 2,000 r.p.m., are recommended. This grinding operation provides a chamfer of approximately 60 degrees (Fig. 2). Subsequently all dust from the grinding operation is removed from the edges, and a solvent (e.g., methylene chloride) is applied by means of a soft brush. The solvent cleans the edges, removes any grease, and has a slight dissolving action on the ebonite. Methylene chloride is a non-inflammable solvent which boils at 60 degrees C.; it is already rather volatile at room temperature. Bottles containing methylene chloride should be kept well stoppered as even minor amounts of methylene chloride in the atmosphere are intoxicating.

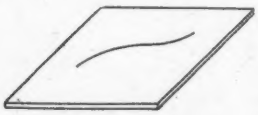


Fig. 1.

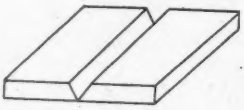


Fig. 2.

The bevelled edges are now brushed five to seven times with a special cement (PE.10) at intervals of approximately 15 minutes. Between the last coat and the actual welding operation a longer interval should be allowed, to make certain that the solvent in the cement has volatilized. The P.E.10 film bonds properly to the ebonite owing to the dissolving action of the methylene chloride, and as this film is thermoplastic, welding to other thermoplastic materials, for instance Vinidur, is possible.

Vinidur filler rods of approximately 2 mm. diameter have so far given the best results. It is not advisable to use thicker filler rods as the P.E.10 film is only very thin and the additional heat required to soften the thicker filler wire would overheat and burn the film.

Welding is carried out with a gas or electrically heated torch (Fig. 3). Due to the fact that thin filler wires only can be used the weld material must be deposited in several layers (Fig. 4).

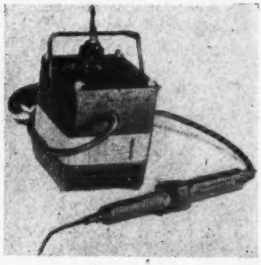


Fig. 3.

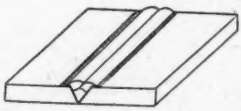


Fig. 4.

In the repair of a typical fracture (Fig. 5), the fracture is first cut so that regular edges are obtained in which a patch can be inserted (Fig. 6). A patch is cut out from Vinidur to fill the gap; in this particular case the fracture extends over a corner of the accumulator box and the Vinidur patch has to be bent over an angle of 90 degrees (Fig. 7). This bending operation can either be achieved by placing the Vinidur patch between two heated

irons (Fig. 8), or by careful warming up with a soft-coal gas flame.

After cooling to room temperature the Vinidur patch is trimmed so that it fits into the fractured part. A bevel of approximately 60-70 degrees is then veed out in both Vinidur and ebonite. Clean-

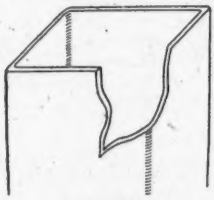


Fig. 5.

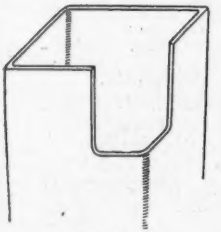


Fig. 6.

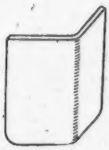


Fig. 7.

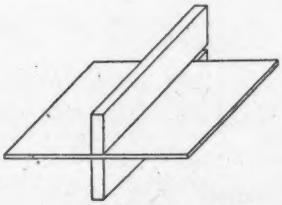


Fig. 8.

ing of the prepared edges with a solvent, application of the P.E.10 cement, etc., has already been described above. It is not necessary to apply the solvent or cement to the Vinidur patch, as Vinidur itself is thermoplastic and therefore perfectly weldable. It is recommended to employ special clamps (as shown in Fig. 9) for the deposition of the root layer. In general, it is advisable not to dress the finished welds, but in cases where two or more battery boxes are combined into one set the welds must obviously be

Fig. 9.

Fig. 10.

dressed to reduce the gap between adjoining boxes to a minimum (Fig. 10).

Ebonite boxes so repaired have been found to be as good in service as new ones.

Rigid polyvinyl chloride is very shortly to be released to the trade in this country. The information given in this article on the repair of accumulator boxes should therefore prove of considerable value to many of our readers. We have always pleaded for a domestic source of this material, but up to the present moment there was the regrettable position that manufacturers of plastics in this country did not take seriously the demand for such a material, although favourable reports have been reaching us continuously regarding German achievements.

At least one firm in Britain has now taken up the manufacture of rigid polyvinyl chloride. If its properties are comparable with "Vinidur" (the trade name for the German material), we predict a great future for it in the fabrication of chemical plant and all kinds of appliances where corrosion is the main bugbear.

THURGAR BOLLE (SUCCESSORS) has been formed as a private company to acquire and amalgamate Thurgar Bollé, H. D. Thurgar, and Injectaplastic. It will carry on the business of makers, modellers, moulders and producers of and dealers in casein, plastics and resins. The capital is £125,000 in 5s. shares.

Book Reviews

Plastics Manual. By H. R. Fleck. pp. 155. Published for Temple Press Ltd. by The English Universities Press, Ltd. 15s. net.

Mr. Fleck can always be relied upon to give us a knowledgeable and accurate account of the plastics industry. What is just as important, he makes his account not only a chemical treatise, but, in addition, a sweeping portrayal of plastics so far as national, international or world production of raw materials is concerned.

We are not quite sure what a "manual" is, for the word is so often used as a misnomer. However, if this means a compilation of concise information for practicians, this is a manual. Yet it is also exceptionally complete, the theory and practical being happily mingled.

It would seem that almost every known plastic is described, together with the chemistry of its condensation or polymerization, its production in the factory, its transformation into moulded or fabricated objects or laminates or textile fibres or electrical impregnators or paint and varnish films. This treatment occupies the bulk of the book. To complete it most adequately, the author includes a chapter on the analysis of both raw materials and finished plastics, and on the mechanical testing normally carried out on the materials; there is another chapter on the mechanical methods of production of mouldings, by compression, extrusion, injection and such processes as laminating and calendering.

This manual is so good that it seems ungracious to enter a note of protest. But since the author in his preface states that "the material has been segregated into two main divisions . . . thermosetting and thermoplastic substances" we looked for it. We wish he had adopted such a method for it would certainly have localized the information. Instead of this, it almost seems as if the chapters were written in alphabetical order and the resins thoroughly mixed.

Statistical Methods in Research and Production. Edited by Owen L. Davies. pp. 292. Published for I.C.I., Ltd., by Oliver and Boyd, 98, Great Russell Street, London, W.C. 28s. net.

According to the foreword by Lord McGowan, this is the first of a series of scientific and technical handbooks which Imperial Chemical Industries intend to publish, based upon information which has accumulated as a result of their manufacturing experience and research. He also adds: "This special knowledge will, it is hoped, be of some value to industrialists and technicians in improving the design of plant and its operation, and thus help British industry to maintain its place against world competition."

The science of statistics is now of paramount importance to our future industrial world, but we should have preferred Lord McGowan had employed the words "industry and technology," instead of industrialists and technicians, for the number of these latter who can understand the book must be woefully small.

This is a highly specialized compilation for statisticians only, a new section of technologists who are mathematicians, chemists, physicists, and engineers, all with profound knowledge of the higher mathematics. The present reviewer being a chemist with very little advanced mathematical knowledge is hardly in a position to review this book adequately. He merely wishes he could understand it and is also convinced of its extreme value, so obvious in understanding the results obtained, say, in the testing of rubber or penicillin, two of the examples given in the book. The reviewer does, however, find much to understand and appreciate in Chapters 8 and 9: Sampling, and Control Charts. There cannot be any doubt of the value of statistical analyses here, and the author has clarified two subjects which have worried the chemical industry in the past.

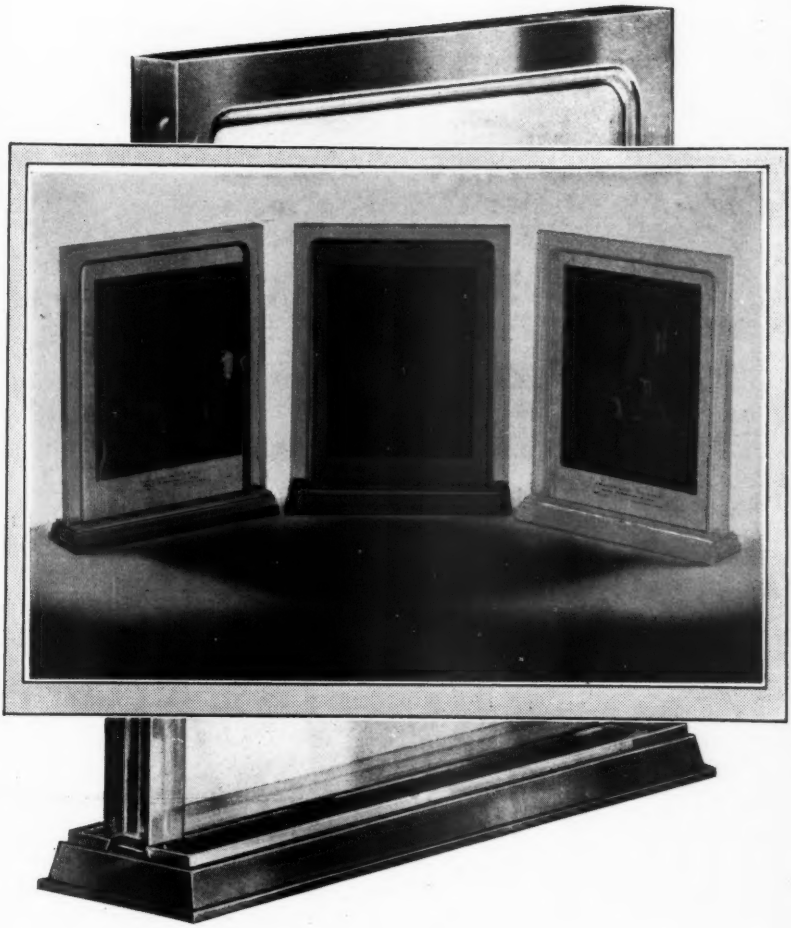
We can conclude by hoping devoutly that there are many more students than we fear who can understand the whole book. Statistics are often derided as being of little value to human affairs, but our future industrial welfare may depend upon their widespread use.

Books Received

The British International Plastics Annual, 1947. London: Croome Hill International, Ltd. 63s.

Newnes' Plastic Manual. By F. J. Camm, H. W. Gilbert-Rolfe and D. C. Nicholas. London: George Newnes, Ltd. 17s. 6d.

British Catalogue of Plastics: an Encyclopædia of the Plastics Industry for all Users of Plastic Materials. London: National Trade Press, Ltd. 50s.



Lovely Frames for Lovely Pictures

Quantities of these transparent frames, which so enhance the beauty of the pictures, are being exported to delight the eyes of buyers abroad. Machined from ½ in. and ⅜ in. "Perspex," they are tinted in many delicate colours. Our thanks are due to the fabricators and designers, J. Starkie Gardner, Ltd., of London, S.W.18, for permission to reproduce the above.

K

World's Industry Employs Plastics

GENERAL ENGINEERING

Moulding Materials. — A new type chart which is easily understood has been developed to cover the physical characteristics of leading commercial moulding materials. It is shown that each property may vary in any given type of material; first, according to the exact formulation used; secondly, according to some special condition. The methods of testing have been clearly specified by significant sketches. (" Machine Design," 1947/Oct./115.)

Unsatisfactory products, causing consumers to lose faith in plastics, can be avoided by applying sound engineering practice to plastics fabrication. An article by the technical service and design staff of Ross-Frederick Corporation outlines how this can be done. Illustrations representing articles correctly developed are given; these include canisters of polystyrene and table lamps of acrylics. (" Scientific American," 1947/Nov./207.)

Plastic deformation of plywood.— Whilst the differences between the elastic properties of wood in three directions, longitudinally, tangentially and radially, have already been studied, H. G. Higgins has investigated the plastic behaviour along these three axes. The effect of moisture and temperature, in particular, has been investigated, a critical temperature being found ("J. Council Sci. and Ind. Research Commonwealth of Australia," 1946/Nov./455), abstracted " Engineers' Digest " 1947/Oct./351).

Moulding Press.—For economical production as well as for laboratory uses, a 30-ton electric hot-plate moulding press has been developed by M. and N. Machine Tool Works, Clifton, N.J. The press can be supplied with any desired amount of openings and with steam-heated hot plates. Special features are a visual temperature indicator and electrically heated and thermostatically controlled plates. (" Modern Machine Shop," 1947/Oct./359.)

General properties of plastics of the phenolic, phenolic-aniline, urea, melamine and cellulose acetate types have been compiled by Shaw Insulator Co., Irvington, N.J. (" Machinery " (N.Y.), Data Sheets, Nos. 595, 596.)

Silicones.—A. E. Williams describes various silicones and their application in engineering, as electrical insulation and as lubricant. (" Mechanical World," 1947/ Nov. 7/467.)

CHEMICAL

Co-polymer resins for transparent, fast-cutting thermosetting plastics have been developed by Pittsburgh Plate Glass Co. Supplied in fully solid state, they are cured at moderate temperatures without elimination of water or other volatile byproduct. Incorporating fillers, pigments and reinforcing materials, they can be cured with or without pressure (Automotive Industries, 1947/Sept. 15/56).

New identification method for complex organic compounds is reported by Drs. Gordijenko and H. J. Schenck, of the cable works of Siemens-Schuckert, Berlin-Gartenfeld. It is based on the different separation of substances out of a number of organic fluids arranged in order of

their increasing polarity. The results are given in the form of tables with symbols indicating the degree of separation. ("Kunststoffe," 1947/June/123.)

Urea and Melamine.—Properties and applications of urea and melamine resin products are summarized by M. H. Bigelow and J. H. Murray. These resins distinguish themselves by good water resistance, high hardness, and mouldability in a wide range of colours. ("Product Engineering," 1947/Aug./140.)

Thioplasts.—Compared with their high resistance against solvents, oxidation and light, the heat resistance and stability of thioplasts, i.e., Thiokol-Perbunan mixtures, is relatively small. H. Roelig has developed a testing apparatus for pressure elastic tests, which now has been used by K. Diehl to investigate the influence of both components on the properties of the ultimate product. As a result, suitable mixtures for general requirements can now be determined. ("Kunststoffe," 1947/**37**/49.)

MISCELLANEOUS

Dip coating "Plastic Seal" has been developed from ethyl cellulose compounds. Advantages claimed are variable thickness of coating from 0.45-0.06 in., controlled exudation of the coating, and availability of colour in red, green and blue, in addition to water-clear. ("Modern Machine Shop," 1947/Oct./257.)

Cover Paper.—Plastic-coated washable green drafting board cover paper is offered by Bruning Co., as a new aid for drawing office efficiency. The material is stated to be heavy enough to cover pinholes and uneven surfaces. ("Machine and Tool Blue Book," 1947/Aug./256.)

Plastic compounds are listed in the 14th edition of Directory of Materials, issued as a supplement to "Machine Design," Oct. 1947. The main entry is by trade name; supplementary entries index the materials according to type and producers.

Vinyl resin-base primer, i.e., a coating serving as a metal-surface conditioning agent and primary coat for temporary protection prior to painting, is said to provide unusual adhesion to steel, galvanized iron, aluminium and other metals; it has been developed by Bakelite Corporation, New York. ("Products Finishing," 1947/Aug./110.)

Honing sticks for general use, in which the abrasive is encased in plastic holders, are being made by Micromatic Hone Corporation, Detroit, Mich. When the abrasive is used up, the entire unit is discarded and a new one inserted. ("Modern Machine Shop," 1947/Oct./234.)

Plastic Coatings.—K. Murray draws attention to some supplementary uses for plastic coating as weather protection, for example, to keep matchsticks dry on boating and camping trips, to tighten loose caps on collapsible tubes, to prevent screwdrivers from slipping from the heads of countersunk screws, etc. ("Popular Science Monthly," 1947/Oct./174.)

SOURCES OF REFERENCE

We wish to remind readers that the sources of reference from which these pages are compiled are not, in general, retained in this office. We cannot, therefore, undertake to supply such originals. Nevertheless, most of the foreign journals referred to are available in the Patent Office Library (Southampton Buildings, Chancery Lane, W.C.2) and in the Science Library (South Kensington). Photo-duplicated copies of articles may be obtained from the Photostat Dept. of the Patent Office.

Cellulose Acetate Plastics

VII.—Plasticizers (contd.)

By
Vivian Stannett

PLASTICIZERS most commonly used in the formulation of cellulose acetate plastics are given in Table 1, together with their more pertinent chemical and physical properties. To indicate the importance of cost, the approximate price per pound at the present time is also shown. The significance of the various properties given has already been discussed or is self-evident, and it is proposed to complete this short discussion of plasticizers with some general notes on the more widely used of the plasticizers enumerated.

DIMETHYL PHTHALATE is a colourless, oily liquid, which in commercial grades has a slight sickly odour. The characteristic smell which is noticeable when heat-forming or machining cellulose acetate plastics is usually due to this plasticizer. It is one of the most popular plasticizers for cellulose acetate, and is found in most commercial compositions. Its popularity is due to its low cost, excellent compatibility, and also to the high degree of flexibility and the thermoplasticity it confers on the plastic. It has a definite gelling action on cellulose acetate which makes for its easy incorporation into the mass with a minimum of volatile solvent being required. This is an important consideration in the manufacture of moulding powders, where the main function of the solvent is to bring the ingredients into a homogeneous whole. It gives very light-fast compositions and causes some reduction in the water-absorption figures; in addition, films containing this plasticizer have an excellent degree of adhesion. It is normally regarded as a completely non-toxic substance.

Among the disadvantages of dimethyl phthalate are its comparatively high volatility, which makes its use undesirable in sheet and film, except as a coupling plasticizer or for such uses as safety glass interlayers, where volatility is of secondary importance. It is much less volatile when used in combination with other less volatile plasticizers such as triphenyl phosphate, and, in any case, has a maximum permanent compatibility of about 15 per cent. There is some tendency for the plasticizer to crystallize at extremely low temperatures, causing brittleness and loss of transparency, although for most applications this is not normally a fact which needs to be considered. The incorporation of dimethyl phthalate causes an increase in the inflammability of the plastic, unless coupled with fire-retarding plasticizers such as triphenyl phosphate.

DIETHYL PHTHALATE, in appearance and most general properties, closely resembles dimethyl phthalate. It has not the same high degree of compatibility and gelling action, but is substantially less volatile. It gives less flexibility and a rather harder composition than does dimethyl phthalate. It is a low-cost plasticizer and it is widely used mixed with dimethyl phthalate, as their properties are to some extent complementary, this combination being used as a coupling plasticizer for those which are less compatible, such as triphenyl phosphate.

TRIPHENYL PHOSPHATE is a white crystalline solid with a very slightly phenolic odour and melting at about 45 degrees C. It is extremely non-volatile and, to all intents and purposes, can be considered as a permanent part of the plastic composition. Its compatibility with cellulose acetate is much less than that of dimethyl and diethyl

Table 1—Plasticizers Commonly Used with Cellulose Acetate

	Molecular weight	Specific gravity	Boiling point deg. C.	Solubility in water %	Flash point deg. C.	Price per lb.
Dimethyl phthalate	194	1.190/20°C.	158/169 (20 mm.)	0.3	132	1s. 4½d.*
Diethyl phthalate	222	1.118/20°C.	174/179 (20 mm.)	0.15	140	1s. 7½d.*
Triphenyl phosphate	326	1.268/60°C.	260 (20 mm.)	0.002	240	2s. 6½d.*
Tricresyl phosphate	368	1.197/25°C.	275/280 (20 mm.)	0.02	230	1s. 10½d.*
Dimethoxyethyl phthalate ..	282	1.170/20°C.	209/261 (20 mm.)	0.9	174	2s. 3d.†
Trichlorethyl phosphate ..	286	1.45/20°C.	210/220 (20 mm.)	0.05	—	5s. 3d.*
Triacetin	218	1.165/20°C.	152 (20 mm.)	0.7	140	1s. 11d.*
o- and p-Toluene ethyl sulphonamides	199	1.188/25°C.	—	0.13	174	
Butyl phthalyl butyl glycollate	336	1.097/25°C.	219 (5 mm.)	0.001	193	3s. 6d.
Ethyl phthalyl ethyl glycollate	280	1.180/25°C.	190 (5 mm.)	0.018	193	to
Methyl phthalyl ethyl glycollate	266	1.220/25°C.	189 (5 mm.)	0.09	190	4s. 6d.‡

* Price data supplied by A. Boake Roberts and Co. Ltd. † Price ruling in September, 1946.
‡ Monsanto Chemicals Ltd.

phthalate. The maximum compatibility varies according to the grade of cellulose acetate employed. About 30 per cent. is usually regarded as the absolute maximum, although even with less than this proportion a quantity of solvent plasticizer such as dimethyl phthalate should always be added to prevent crystallization or exudation.

Cellulose acetate yields tough and flexible plastic compositions with triphenyl phosphate, which are considered harder and more "solid" than those containing the liquid phthalate esters. Triphenyl phosphate also imparts good water resistance and, above all, excellent fire-resisting properties. Compositions containing about 20 per cent. do not support combustion. For this reason, and also because of its high degree of permanence, triphenyl phosphate is one of the most widely used plasticizers with cellulose acetate. It is a toxic material and is not used for plastics where contact with foodstuffs, etc., is probable. Also it has not the high degree of light-fastness which is a feature of the above-mentioned phthalates, although it is sufficiently light-fast for practically all commercial applications.

TRICRESYL PHOSPHATE is a clear, oily, colourless liquid. It has a very low compatibility for cellulose acetate, and usually not more than about 10 per cent. is incorporated into the plastic composition. Its great advantages are its excellent stability and low volatility. It is virtually non-volatile and imparts excellent weathering properties to the plastic. It is not widely used for cellulose acetate plastics owing to its low compatibility, but is used in special compositions, particularly where a low total plasticizer content is required with maximum permanence. It is a cheap plasticizer which resembles triphenyl phosphate in many of its properties.

TRIACETIN is an oily, clear liquid, which has excellent compatibility with cellulose acetate, and was formerly very widely used as a plasticizer. Its value is reduced by its high volatility, and it also has a comparatively high water solubility, which lowers the water resistance. In addition, it is too readily hydrolysed to make for good ageing and weathering properties. For these reasons, it has now been largely superseded by the alkyl phthalate plasticizers, for most commercial plastics formulations.

DIMETHYL GLYCOL PHTHALATE, di (methoxy ethyl) phthalate, is an oily liquid, possessing high compatibility with cellulose acetate, giving a tough and flexible product. It also has a very low volatility and is used for the formulations of high-quality plastic compositions. It has some tendency to "sweat" from plastic sheeting, etc., if used in an excessively high proportion. It is considerably more expensive than the plasticizers described above, which also limits its use to special-purpose compositions.

TRICHLORETHYL PHOSPHATE is a clear

liquid with a very high compatibility for cellulose acetate. It has a low water solubility and good petrol resistance. The outstanding advantage of this plasticizer is that it has excellent fire-retarding properties, and it is widely used in the preparation of film and products where a high fire resistance is required. It also has a high degree of permanency, although it is rather too expensive for use in general-purpose compositions.

The other plasticizers listed are too expensive for general use, but are employed in the formulation of high-grade products where a well-plasticized material with good ageing and weathering properties is required. They all have good moisture resistance and excellent compatibility and find their way into a great many commercial compositions where quality is regarded as more important than very low cost.

Colour Additions to Cellulose Acetate Plastics

Even the best grades of commercial cellulose acetate are slightly yellow in colour, and it has become the custom in the trade to counteract this by the addition of blue or violet dye. The yellow colour is due to poorer light transmission in the blue than in the yellow range, and by adding a little blue dye this cuts down the yellow to give an overall neutral effect. The explanation is shown graphically in Fig. 1. It will be obvious that, although the colour becomes more neutral, the total transmission is cut down by several per cent., so in cases where a very high total transmission is more important than a slight yellowness, the tinting operation is omitted. The amount of dye added is, of course, very small and is only added for transparent colourless products. To match exactly the "colourless" film and sheet is a special job and each batch needs to be adjusted separately to give a standard "neutral" colour. This is, of course, particularly true of thick, moulded-sheet products.

Owing to their freedom from natural colour, cellulose-acetate plastics have a virtually limitless colour range from delicate transparent shades to heavy opaque colours. The plasticized cellulose acetate base is coloured by the incorporation into it of the necessary dyes, pigments and fillers. The mixing of colours and the selecting of the correct colouring matter to give the desired results is a highly specialized job, and many factories have separate laboratories entirely devoted to the problem of colour. It will be sufficient here, however, to

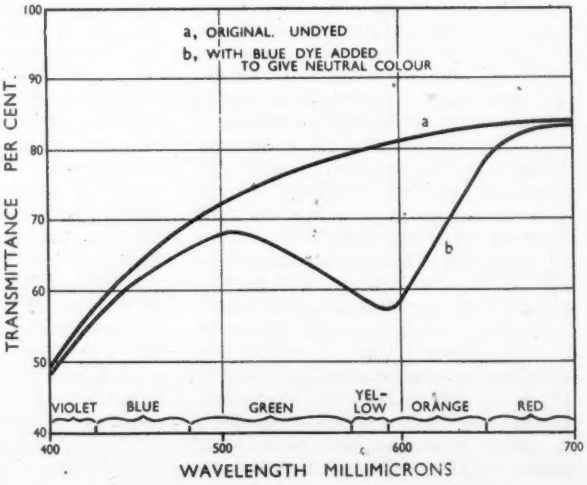


Fig. 1. — Graphic representation of colour and light transmittance through cellulose acetate.
(Courtesy of Hercules Powder Co.)

outline one or two points regarding the choice of colouring material and to give the main types of dyestuffs, pigments and filler commonly used for cellulose acetate plastics.

Dyes

Dyes, generally, may be defined as colouring materials soluble in a neutral readily available liquid such as water, alcohol or hydrocarbons. In order to be of use for cellulose acetate plastics, a dyestuff needs to be soluble in the plastic itself and also to be soluble in a suitable organic solvent to enable its addition to the plastic mass during manufacture. Most spirit soluble dyes and also a number of oil soluble dyes are suitable for use with cellulose acetate. The dyestuff is usually added in the form of a solution to the plastic dough or dope at the mixing stage. If a concentrated amount of colour is needed, the dye solution is generally filtered before adding, to remove the insoluble gritty impurities which are usually present in commercial dyestuffs.

In addition to having the required solubility characteristics, the dye must also produce a colour which is reasonably light fast. This is best determined practically by simple exposure tests on the fadometer. This is a standardized piece of equipment with which samples of dyed film, etc., can be exposed under standard conditions to a carbon arc lamp. With the normal type of lamp, 200 hours' exposure is reckoned to be roughly equivalent to one year's outdoor exposure, although the two can never really be co-ordinated and opinions differ on this point. Nevertheless, the fadometer does provide an accelerated method of test for light fastness where, as is usually the case, it is impracticable to await the results of normal outdoor exposure tests. Unfortunately, very often the brightest and strongest colours are the least light stable; for example, the triphenyl methane types and most of the more usual basic dyestuffs such as some Acridine colours and Rhodamine colours.

In recent years, however, a number of very complete ranges of good light-fast dyes suitable for cellulose acetate plastics have become available commercially, including anthraquinone types and some azo dyes. As the cellulose acetate itself can affect the light fastness of the dye, it is best to carry out a practical test before use even on allegedly light-fast products. A more important effect, which is very noticeable in practice, is the effect of a dispersed filler or white pigment. If these are used in combination with an organic soluble dyestuff, the light fastness of the colour is very much reduced by the presence of the pigment, often to the point of being virtually useless for most commercial applications. In other words, a dyestuff usually gives a far superior performance when used alone to give a transparent colour, than when used in combination with a pigment to give a transluscent or opaque colour. Intermediate transparent shades can, of course, be readily produced by the blending of two or more suitable colours, and with experience and a good range of colours available, a good colour matcher can reproduce a given colour with very fair exactness.

Owing to the comparatively high temperature to which cellulose acetate plastics may be subjected, particularly during moulding operations, the stability of the dye to heat is also an important item and should accordingly be tested before a dyestuff is chosen. This can be carried out by heating the dyed sample at the maximum temperature to which the product is likely to be subjected, for various periods of time, and the samples compared with each other and with the original.

Finally, the possibility of colour leaching and bleeding out of the plastic should not be overlooked, especially if the plastic end product is to be brought into contact with organic liquids and creams during use; for example, in the case of acetate packs for cosmetic creams, etc.

Pigments

Pigments may be defined as solid insoluble coloured materials. They impart their colour to the plastic as a

whole when smoothly dispersed in the solid mass. With one or two exceptions, the range of solid colours found useful in paints, rubbers and plastics are also useful with cellulose acetate plastics. Consequently a huge range of pigments is available for use, including all the basic classes such as the organic toners and lakes, synthetic inorganics, and the natural mineral pigments. The lakes are organic colours blended with inorganic extenders either by being precipitated on to the extender or by mechanically blending together. In the former case the extender acts as a mordant. The extender is usually an inert white material such as alumina or blanc fixe.

Organic colours and lakes are by far the brightest and most concentrated colours available, and also have excellent light fastness. The inorganic colours are cheaper and are usually completely light fast and rather more heat stable than the organic colours. Owing to the small proportion of lake needed, however, the difference in price is not always as marked as it would at first appear, and for many colours, particularly, of course, pastel shades, a lake can be substantially diluted with a white pigment or extender and still give a colour of the desired intensity.

Inorganic pigments are usually rather duller than the lakes, and tend to dilute to a greyish hue rather than a delicate pastel shade. For solid yellow and brown colours, however, inorganic pigments, such as the chromes and umbers, are still very widely used and give excellent products very fast to light and heat. For greens, blues and reds, the older inorganic colours, such as Guignet's green, ultramarine, etc., are being superseded by the huge range of brilliant lake colours which are now commercially available.

White pigments for cellulose acetate plastics generally narrow down to a choice between zinc oxide and titanium oxide. The former is still widely used because of its cheapness, although it is said to interact with the cellulose acetate to some extent at the moulding temperature. Titanium oxide has a far greater covering power than zinc oxide, and considerably less of the material need be used to give a similar result. This helps to counteract its high price as compared with zinc oxide. As with dyestuffs, many colours are made by blending two or more pigments together, and pastel shades and translucent effects are made by blending a colour with a white pigment, titanium oxide being particularly useful.

Blacks are made by the use of carbon black or lampblack together with a "black" dye, usually spirit soluble nigrosine. This type of combination gives a very opaque and glossy black product at low cost.

Fillers

Owing to the excellent impact strength of cellulose acetate, the use of filler, other than to give opacity and weight or to extend the amount of plastic available, has never become general practice. The usual mineral fillers for these purposes include blanc fixe, silica, zinc oxide, etc.; powdered mica has also been used. The addition of mineral fillers usually causes some reduction in impact strength, although heat resistance is often somewhat improved. Wood flour, fibrous fillers, etc., such as are used for phenolics, are not (except in rare instances) ever employed with cellulose acetate plastics.

In addition to normal dyes, pigments and fillers mentioned above, a number of special effects can be brought about by the use of special types of these materials. These include pearl and metallic effects, and also fluorescent and luminous colours. The method of incorporating the colouring material into the plastic will be dealt with later.

(To be continued.)

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(1) *Hercules Powder Co. technical literature.* **(2)** *Fordyce and Meyer, Ind. Eng. Chem.*, 1940/**32**/1053. **(3)** *Durrans "Solvents." Chapman and Hall*, 1944. **(4)** *Jordan, "Technology of Solvents." Leonard Hill*, 1940. **(5)** *Matiello, "Protective and Decorative Coating Materials," Vol.* 2. **(6)** *Clewell and Paune, Ind. Eng. Chem.*, 1937/**29**/750. **(7)** *Clark, Ind. Eng. Chem.*, 1943/**35**/368. **(8)** *Geigy Co., technical literature.* **(9)** *Monsanto Co., technical literature.*

Plasticization of Thermoplastics with Special Reference to Stability (contd.)

By E. E. Halls

AT this stage it is useful to reproduce some basic data from American sources, abstracting a paper by C. R. Fordyce and L. W. A. Meyer, "Plasticizers for Cellulose Acetate and Cellulose Acetate Butyrate," which was published in "Industrial and Engineering Chemistry," August, 1940 (p. 1053).

This particular article gives an account of very extensive and fundamental researches into the suitability of various plasticizers for cellulose actetate and cellulose acetate butyrate. When these thermoplastics are used, whether for sheet or film, rod, tube or other extruded form, moulding powder, or as lacquer coatings or impregnating media, they are almost

Table 1.—Retention of Plasticizers by Cellulose Acetate (Acetyl 40.5 per cent.)

	Initial content	Roof					Oven (100°C.)				Water bath (40°C.)			
		20 hr.	60 hr.	1 wk.	1 mth.	3 mth.	20 hr.	60 hr.	100 hr.	160 hr.	20 hr.	60 hr.	100 hr.	160 hr.
Benzophenone	49	45	41	39	..	..	17	12	10	9	19	12	10	8
Butyl phthalyl butyl glycollate	55	55	55	54	53	51	..	24	18	12	49	39	34	28
Camphor	7	5	5	5	..	..	..	..	..	..	3	2	1	0
o-Cresyl-p-toluene sulfonate	35	34	34	32	25	..	24	21	19	14	30	27	26	24
Cyclohexyl-p-toluene sulfonamide	35	32	32	31	31	31	29	27	25	22	29	28	27	26
Diamyl phthalate	19	19	18	18	16	16	15	15	15	14	18	18	17	17
Dibutyl phthalate	32	32	31	30	28	11	20	19	18	17	29	27	26	25
Dibutyl succinate	23	15	9	7	5	3	3	3	3	3	4	1	1	0
Dibutyl tartrate	54	47	43	40	34	6	22	18	17	16	23	21	19	17
Diethoxyethyl adipate	35	22	14	10	9	6	17	9	7	6	5	4	4	3
Diethoxyethyl phthalate	56	48	43	40	38	..	38	..	..	..	25	19	16	14
Diethyl adipate	21	4	3	3	1	..	6	6	6	5	1	0	0	0
Diethylene glycol dipropionate	36	5	4	2	1	..	..	..	..	..	1	1	1	1
Diethyl phthalate	53	41	36	32	30	26	21	18	18	17	26	22	19	14
Diethyl sebacate	17	15	13	12	10	6	7	7	6	6	7	4	3	2
Diethyl succinate	9	3	2	1	0	..	4	3	3	2	0	..	..	..
Diethyl tartrate	49	10	10	9	7	4	16	14	14	12	5	5	4	4
Dimethoxyethyl adipate	53	23	14	10	9	6	18	12	11	8	5	5	5	5
Dimethoxyethyl phthalate	61	53	48	45	41	34	45	38	34	31	28	20	16	14
Dimethyl phthalate	42	29	27	25	24	20	16	14	13	12	17	11	8	6
Dipropyl phthalate	60	53	49	46	37	32	22	21	20	19	33	28	26	24
Ethyl benzoyl benzoate	60	59	59	58	*	..	40	31	28	26	50	46	44	39
Ethylene glycol diacetate	9	3	2	1	0	..	4	3	2	2	0	0	0	0
Ethylene glycol dibutyrate	15	4	3	3	2	..	5	4	4	4	1	0	..	..
Ethylene glycol dipropionate	10	3	2	2	1	..	4	3	3	3	0	0	0	0
Ethyl phthalyl ethyl glycollate	59	57	56	55	53	47	29	27	25	21	38	31	25	21
Methyl benzoyl benzoate	61	57	57	56	*	..	36	33	32	29	52	49	46	42
Methyl phthalyl ethyl glycollate	57	54	53	52	46	43	38	31	29	27	38	29	24	18
o- and p-Toluene ethyl sulfonamide	58	51	49	47	44	40	37	29	26	25	33	24	20	16
Triacetin	43	29	23	20	15	13	14	12	11	10	12	9	8	6
Tributyl citrate	62	58	56	54	50	43	32	25	24	22	34	28	27	24
Tributyl phosphate	40	28	27	23	18	15	14	13	12	12	15	14	12	9
Tributyrin	58	49	47	44	37	28	19	18	18	17	25	22	20	17
Tricresyl phosphate	21	21	20	18	18	17	20	19	18	17	18	18	18	17
Triethylene glycol diacetate	51	10	9	8	6	4	14	12	11	10	5	5	5	4
Triethylene glycol dibutyrate	56	32	25	22	17	7	14	12	12	11	6	6	5	5
Triethylene glycol diproprionate	53	22	16	14	11	7	14	11	10	9	6	6	5	4
Triphenol phosphate	31	29	29	29	28	28	26	23	22	21	27	26	24	23
Tripropionin	55	39	37	34	27	23	19	17	16	14	21	17	15	12

* Indicates brittleness.

Table 2.—Comparison of Physical Properties of Plastics composed of Cellulose Acetate (38.5% Acetyl) and Cellulose Acetate Butyrate (37% Butyryl, 13% Acetyl) with various Plasticizers

	Dimethyl phthalate						Diethyl phthalate		
	Cellulose acetate			Cellulose acetate butyrate			Cellulose acetate		
Parts plasticizer/100 parts base	37.8	30.0	22.6	15.8	11.0	6.3	59.5	49.0	38.7
Flow temp. (°F.)	266	285	307	266	285	307	266	285	307
Elongation, %	8.0	6.5	5.0	23.8	22.7	21.8	40.0	28.6	20.8
Tensile strength, lb./sq. in. ..	6,630	8,100	9,930	4,690	5,520	6,540	2,860	3,850	5,100
Flexural strength, lb./sq. in. ..	11,140	14,200	17,000	7,840	9,240	10,950	3,930	6,050	8,800
Rockwell hardness, M	79.5	90.5	101.1	72.4	80.1	86.4	49.0	59.7	75.5
Water absorption, % (48 hrs.)	2.13	2.47	3.24	1.45	1.58	1.68	1.78	2.13	2.38
Leaching, % (48 hrs.)	0.58	0.52	0.45	0.41	0.29	0.22	2.18	1.11	0.52
Loss in wght.%(1 week at 150°F.)	2.40	0.86	0.53	1.06	0.60	0.46	6.67	3.85	1.96
Shrinkage, % (1 week at 150°F.)	1.38	0.11	0.09	0.89	0.48	0.19	3.02	1.53	0.70

	Diethyl phthalate			Dimethoxyethyl phthalate					
	Cellulose acetate butyrate			Cellulose acetate			Cellulose acetate butyrate		
Parts plasticizer/100 parts base	17.0	12.0	7.0	62.5	51.3	39.6	18.5	13.2	7.8
Flow temp. (°F.)	266	285	307	266	285	307	266	285	307
Elongation, %	26.2	24.7	23.4	49.2	33.3	25.0	28.9	26.7	24.6
Tensile strength, lb./sq. in. ..	4,410	5,340	6,470	2,760	3,700	4,880	3,710	4,680	5,870
Flexural strength, lb./sq. in. ..	7,390	8,920	10,800	3,670	5,700	8,390	6,430	8,240	10,480
Rockwell hardness, M	65.5	75.2	84.3	20.6	44.3	67.2	60.1	71.2	82.0
Water absorption, % (48 hrs.)	1.40	1.48	1.82	2.64	2.90	3.23	1.58	1.73	1.79
Leaching, % (48 hrs.)	0.33	0.27	0.20	1.98	1.62	0.51	0.26	0.20	0.15
Loss in wght.%(1week at 150°F.)	0.54	0.40	0.21	0.41	0.34	0.23	0.19	0.17	0.13
Shrinkage, % (1 week at 150°F.)	0.33	0.27	0.13	0.29	0.21	0.17	0.13	0.11	0.09

invariably compounded with plasticizers. This may be necessary for the actual production of the product or to impart the requisite degree of flexibility or softness, or to assist in fabrication processes through which the product has to pass.

Advances in industrial organic chemistry have caused the availability of a tremendous range of materials that fall within the category of plasticizers. The list is a formidable one, and it is not a simple matter to decide which to use in relation to specific properties required. It is not always easy to prepare an experimental mix from which to study the product and come to a decision upon the suitability of the plasticizer. The product may meet all the immediate needs with respect to mechanical and fabrication properties, but the stability of chemical and of physical properties is not easy to determine in a short period of time. It is evident that the plasticizer employed must be compatible with the product in which it is compounded at all stages, i.e., in the bulk and in the final form, whether it is film or sheet, tube or moulding powder, etc. It must remain compatible, that is completely in solution and dispersion under all conditions of service, independent of the variations in temperature or humidity that may be encountered. It must likewise remain stable under such conditions, free from any tendency to split up by hydrolysis or oxidation.

To a large degree, the actual properties of the plasticizer itself are the determining feature, but tests in this direction need to be far more discriminating than would be applied in the majority of normal applications. Thus, with regard to properties such as solubility or miscibility with water, degree of hydrolysis or acidity formation and oxidation, the degree of change that may occur under normal circumstances may be relatively very small and regarded as nil, whereas in this particular application it may assume considerable importance. It has to be borne in mind that, with the plasticizer dispersed in the plastic material, it may present a much larger surface to the decompositional agencies and may be far

Table 3.—Comparison of Physical Properties of Plastics Composed of Cellulose Acetate Butyrate (37% Butyryl, 13% Acetyl), with Various Plasticizers

	Dibutyl phthalate			Diamyl phthalate			Triphenyl phosphate		
Parts plasticizer/100 parts base	21.0	14.6	8.1	21.5	15.0	8.3	22.5	15.3	8.8
Flow temp. (°F.)	266	285	307	266	285	307	266	285	307
Elongation, %	36.0	30.0	25.8	37.6	30.5	26.6	34.0	27.0	20.0
Tensile strength, lb./sq. in. ..	4,280	5,250	6,380	4,220	5,180	6,340	4,500	5,450	6,300
Flexural strength, lb./sq. in. ..	6,380	8,160	10,420	6,240	8,080	10,330	7,200	8,850	10,700
Rockwell hardness, M	57.6	69.4	80.7	56.5	69.2	80.4	72.0	80.7	87.5
Water absorption, % (48 hrs.)	1.25	1.38	1.80	1.22	1.35	1.83	1.34	1.44	1.63
Leaching, % (48 hrs.)	0.27	0.22	0.19	0.20	0.18	0.14	0.08	0.08	0.08
Loss in wght.%(1 week at 150°F.)	0.52	0.45	0.36	0.51	0.43	0.34	0.14	0.13	0.11
Shrinkage, % (1 week at 150° F.)	0.41	0.29	0.10	0.39	0.28	0.14	0.08	0.06	0.05

	Tricresyl phosphate			Dibutoxyethyl phthalate			Dibutyl sebacate		
Parts plasticizer/100 parts base	27.4	19.2	11.6	22.6	15.7	9.3	23.6	16.5	9.5
Flow temp. (°F.)	266	285	307	266	285	307	266	285	307
Elongation, %	48.8	33.0	26.7	32.5	29.0	25.8	66.5	46.0	34.2
Tensile strength, lb./sq. in. ..	3,580	4,550	5,760	3,270	4,250	5,460	3,340	4,320	5,540
Flexural strength, lb./sq. in. ..	5,000	7,100	9,700	5,320	7,470	10,100	3,500	5,400	7,820
Rockwell hardness, M	48.9	62.4	76.5	54.6	66.2	78.8	40.7	57.0	74.4
Water absorption, % (48 hrs.)	1.18	1.27	1.50	1.37	1.49	1.62	1.38	1.48	1.60
Leaching, % (48 hrs.)	0.08	0.07	0.07	0.08	0.07	0.05	0.22	0.19	0.13
Loss in wght.%(1wzek at 150°F.)	0.13	0.12	0.10	0.16	0.13	0.09	0.38	0.25	0.15
Shrinkage, % (1 week at 150°F.)	0.05	0.02	0.00	0.08	0.07	0.05	0.07	0.05	0.03

more vulnerable to attack than it is in bulk. Consequently, the investigators studied a large range of plasticizers and paid much attention to the determination of solubility in water, free acidity and boiling-water stability. It is considered that the most useful plasticizers have the lowest water solubility, and that this is a characteristic which should be insisted upon. Free acidity and tendency to form acidity are also factors that are not considered favourable in good plasticizers, as it is logical to anticipate that plastics exposed to damp conditions would undergo some deterioration.

The durability of plasticized cellulose ester compositions can be assessed more directly by the examination of films containing varying quantities of the plasticizers under consideration. In general, these are most easily prepared by evaporation of solutions of the cellulose ester and plasticizer or plasticizer mixture, and films of one or more thickness can be prepared. Suitable precautions are necessary in preparing these if the results are to be compared with those obtained on sheet or moulded products, i.e., accuracy in proportions used and assurance that during evaporation losses do not occur. In this respect, the volatility of the plasticizer enters and in some cases the quantity of plasticizer that can be incorporated by the solvent-evaporation method is very limited. This may vary again with the composition of the plastic, and the tabulated data given refers to the high-, medium- and low-acetyl cellulose acetate of 40.5 per cent., 38.5 per cent. and 37.5 per cent. acetyl content respectively.

The maximum quantity of plasticizer that can be tolerated in a composition obviously depends upon the performances for which the product is intended; for example, if it is only a question of producing an homogeneous uniform composition, quite high percentages can be incorporated, but if conditions of storage, temperature fluctuation, moisture fluctuation, and so on, are to be encountered and withstood, discretion is required with respect to type of plasticizer and quantity. The maximum compatibility values, therefore, give no indication whatsoever of stability under ageing conditions, nor information as to whether the plasticizer will be retained over a period of time under any particular set of conditions. As a general rule, it can be

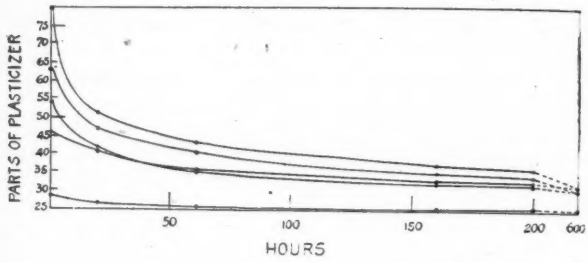


Fig. 1.—Retention of diethyl phthalate in cellulose acetate films under out-of-doors exposure.

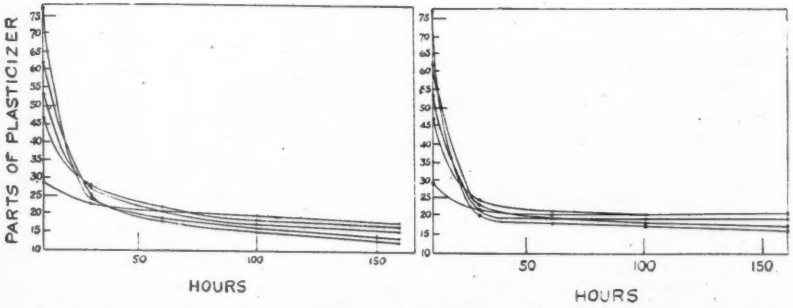


Fig. 2.—Retention of diethyl phthalate in cellulose acetate films immersed in water at 40° C. (left) and incubated at 100° C. (right).

assumed that plasticizer is gradually lost and that the rate of loss diminishes with time. Figs. 1-4 give a graphical representation of this point.

Fig. 1 shows the loss of diethyl-phthalate plasticizer from cellulose-acetate films under conditions of out-of-doors exposure. Curves are given for various percentages and are of similar form, except, of course, the higher the plasticizer content, the greater the initial rate of loss. This initial high rate is evidenced during the first 24 hrs. of exposure.

Fig. 2 gives curves for similarly plasticized film immersed in water at 40 degrees C. and exposed to 100 degrees C. respectively. Again, the most marked loss of plasticizer is during the initial 24 hrs.

Fig. 3 refers to a wider range of plasticizers under a range of conditions. Each of these is depicted in a separate figure, with the curves A, B and C representing open-atmosphere exposure on the roof, exposure to oven heat at 100 degrees C. and water immersion at 40 degrees C. respectively. The form of the curves is similar to that given for the previous materials tested, with maximum change during the initial 24-hr. period.

Cellulose-acetate butyrate of 35-40 per cent. butyryl content has particular merits for moulding compositions, especially because it is more compatible with the highly water-resistant and non-volatile plasticizers than is cellulose acetate. It therefore gives a wider choice to the manufacturer in the formulation of his compositions and the possibility of meeting moulders' requirements more closely. Further, the indications are that these plasticizers are held more permanently and for higher concentrations than those used ordinarily for cellulose acetate. This is shown in Fig. 4, which gives the plasticizer retention for cellulose-acetate butyrate of 37 per cent. butyryl and

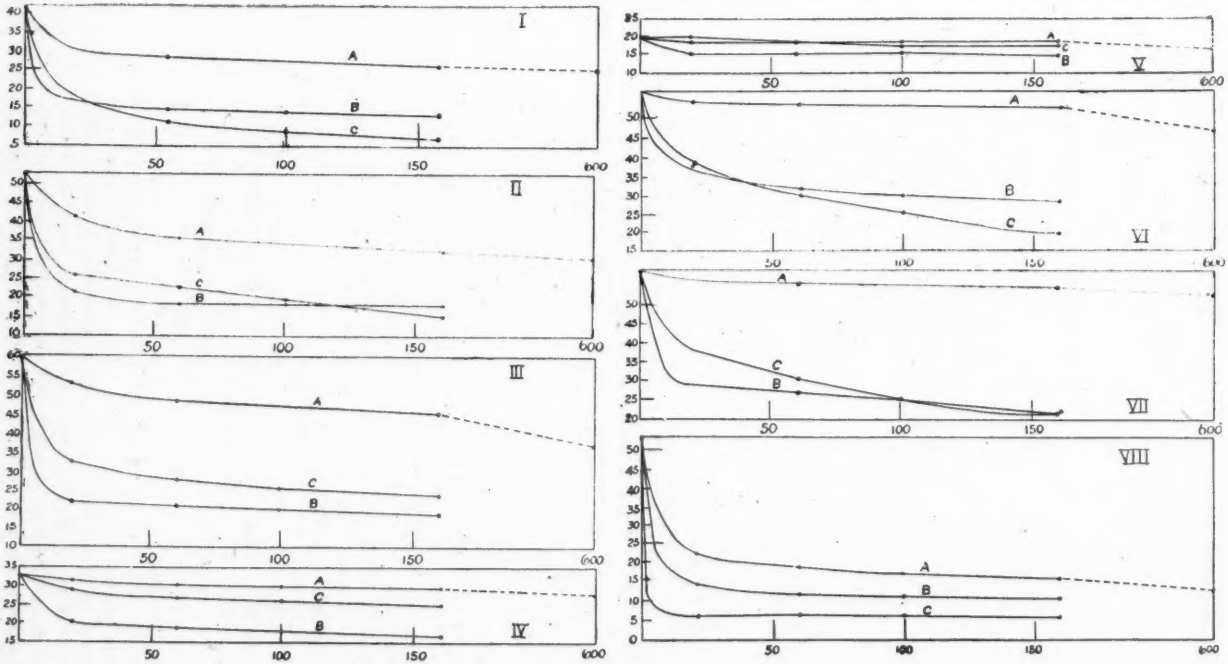


Fig. 3.—Retention of plasticizers in cellulose acetate films. A, Roof exposure; B, oven, 100° C.; C, water, 40° C.

I, dimethyl phthalate; II, diethyl phthalate; III, dipropyl phthalate; IV, dibutyl phthalate; V, diamyl phthalate; VI, methyl phthalyl ethyl glycollate; VII, ethyl phthalyl ethyl glycollate; VIII, triethylene glycol dipropionate.

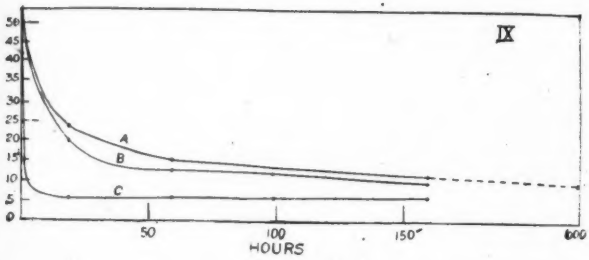


Fig. 3 (continued).—Retention of plasticizers in cellulose acetate films. IX. dimethoxyethyl adipate

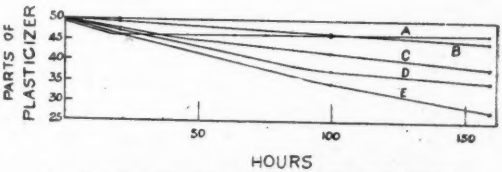


Fig. 4 (right).—Retention of plasticizers in cellulose acetate butyrate (37 per cent. butyryl, 13 per cent. acetyl) films immersed in water at 40° C.

A. Dibutyl sebacate; B. Diamyl phthalate; C. Butyl phthalyl butyryl glycollate; D. Triphenyl phosphate; E. o-Cresyl-p-toluene sulphonate.

13 per cent. acetyl content. The curves are for water immersion at 40 degrees C. and cover a range of plasticizers, namely, (1) dibutyl sebacate, (2) diamyl phthalate, (3) butyl phthalyl butyryl glycollate, (4) triphenyl phosphate, and (5) o-cresyl-p-toluene sulphonate.

In the experimental work done by Fordyce and Meyer, compatibility with cellulose acetate was determined by coating samples of cellulose-acetate film from acetone solutions. Cellulose acetate of the high-, medium- and low-acetyl contents were used and solutions of acetone containing increasing quantities of each plasticizer. Films were examined after the solvent had evaporated to determine the maximum quantity of plasticizer that would yield a clear film. Films were then prepared having this maximum plasticizer content and were completely cured by oven heat at 55 degrees C. for 18 hrs. and then the plasticizer contents were determined by analysis. In practice it was found that duplicate tests agreed within 5 per cent., and the tabulated data given are the results rounded off to the nearest 5 per cent. of plasticizer content as the maximum compatibility.

For plasticizer-retention tests, films having a known plasticizer content were prepared as described under compatibility. Samples 3 ins. square were then cut for the water-immersion, oven-heat and roof-exposure tests.

The roof exposure consisted in placing the samples on an exposure frame, and they were washed at intervals to remove surface dirt, then dried for 2 hrs. at 55 degrees C. and weighed. Losses in weight were calculated as loss of plasticizer. The water-immersion test was carried out by totally immersing the samples in a constant-temperature bath at 40 degrees C. The volume of the bath was large, so that there should be no interference by plasticizer removed. The specimens were washed at intervals, then dried for 2 hrs. at 55 degrees C. and weighed. Again the loss was calculated as plasticizer loss. The oven-heat test was carried out at 100 degrees C., with the samples weighed at intervals.

The fact that the losses in weight in these tests represented a reliable measure of plasticizer loss was shown separately by analysis of a series of test specimens before and after water immersion.

LETTERS TO THE EDITOR

Correspondents are reminded that a stamped and addressed envelope should be enclosed in all cases where a personal answer is desired. It is understood that any letter received may be published at the discretion of the Editor.

Unimpregnated Radio Components

Sir,—Whilst roaming around "Radiolympia" in search of the impact of war-time technical research in the radio industry on post-war design, particularly in the field of components, I was horrified to find that the vast majority of such essential units as transformers, chokes, etc., were being shown in a "dry," i.e., unimpregnated, condition. This was the case not only on the stands of component manufacturers, but also in the fabricated equipments shown by members of the industry whose names are household words!

This seemed to me to be a most retrograde step, and forthwith I made inquiries at a technical level as to the reasons for this change, expecting to be told that it was a matter of expense or shortage of suitable impregnants. Judge of my added horror, therefore, when I was informed that the reason was that many manufacturers were not convinced of the benefits of impregnation! This statement seems to be a deliberate rejection of lessons learnt during war-time, when—even before the advent of that never-to-be-forgotten word "tropicalization"—the impregnation of transformers and chokes with either varnish, bitumen or wax was an automatic process called for on all Service specifications.

To-day, when the need of the country is for increased exports, and the Board of Trade's export promotion department at "Radiolympia" was showing statistics of the fabricated equipment, components, etc., which had been, and were being, exported to all countries of the world, we find that many of these exportable commodities are unsound technically.

It is a well-known fact that if components can be kept free from permeation of moisture they will function satisfactorily, and thus (although it is also known that there are no impermeable impregnants) the use of varnish films, bitumen and wax coverings does help to a very great extent to reduce the rate of permeation of moisture vapour into the interior and so increases the length of efficient life of the component many fold.

If the components are left without this superficial protective coating there are many possibilities of rapid failure of the component. Not the least of these is the electro-chemical reaction produced when a current flows through copper wire in contact with moist cellulose, which results in the destruction of the copper. This reaction is accelerated in the presence of a dried oleo-resinous varnish film.

Consider the case of a typical transformer which is wound with conventional enamelled copper wire and is paper interleaved. Here it is impossible to guarantee freedom from pin holes of enamelled copper wire. It is true, therefore, that there must always be weak points which are not proof against the applied potential of 50 volts. If, therefore, there is no added protective coating to such a transformer, all the conditions for breakdown by this action are present.

If, however, the transformer is impregnated with a suitable varnish or bitumen, or, as per the Admiralty requirements, covered with a coating of microcrystalline wax, then it is (or should be) automatically dried out thoroughly before treatment, which means that before the above dangerous action can commence the moisture vapour has to permeate a layer of insulant, a procedure which, under normal conditions, takes quite a long time. This can be seen when it is considered that the permeability coefficient of a typical varnish and a bitumen have been said to be 2.1×10^{-8} and 1.4×10^{-8} respectively, measured as

mgms./c.m.²/hour/mm. mercury vapour pressure potential/25 degrees C.

I feel extremely perturbed about this state of affairs, and I am of the opinion that it should be ventilated without delay in an endeavour to persuade the designers responsible for this retrograde step to consider their decisions and to raise the general production of radio equipment back to that peak of technical excellence which was reached during the war years.

C. R. PYE, chief varnish chemist,
Indestructible Paint Co., Ltd.
Park Royal, N.W.10.

New Plastic Tableware

Sir,—As, in your November issue, you referred to my recent strictures in the "Observer" on streamlining, quoting in an editorial some of my remarks on the misguided efforts of the plastics industry in this connection, I may perhaps be allowed some space to comment further on plastic products.

Although plastic materials are by no means as new as might be supposed from occasional references in the popular Press, it will, I think, be conceded that, compared with the traditional materials which, in some instances, they are endeavouring to replace, they are young and in some respects "inexperienced." The potentialities of these "new" materials are so great that it is not surprising that manufacturers are sometimes a little uncertain regarding their proper use.

In connection with the use of plastic materials for the manufacture of tableware, surely its light weight indicates the field in which it may be best employed, as, for instance, picnic outfits, and similar uses in which ease of transportation is a predominating factor? This important quality of lightness is, however, a disadvantage in a number of other possible applications, particularly as a substitute for the common form of hotel-ware. The rapid acceleration of waiters' trays piled with light-weight cups is almost certain to result in dropped cups when collecting empties. There is also the question of prejudice against drinking from cups of material other than china or earthenware, although admittedly in these days of shortages such prejudices are of less importance than formerly, and may not return when shortages are overcome.

With regard to stacking or nesting, important as this is, the case for plastic cups, saucers and egg-cups as given in the article entitled "New Plastic Tableware" is overstated, because there are many designs of egg-cups in materials other than plastic which will occupy far less space than the examples illustrated to provide a comparison between porcelain and plastic articles. Moreover, the worst possible example of nesting design of porcelain cup was selected for the purpose of demonstrating the advantages of the plastic cup, the handle of which can have been designed only to facilitate nesting. The more usual hook form of handle to which you refer in your editorial is almost equally useful from the nesting angle, and if properly designed, may be functionally a far better proposition than the German design.

A point on which criticism may be levelled at the German design of combined egg-cup and saucer is that, in the pursuit of close nesting, the underside presents very sharp re-entrant angles, as shown in the cross-section, which would be dirt-collecting and difficult to clean. This would not only be undesirable from the cleanliness viewpoint, but would also prevent the desired close nesting. As the articles in question are produced from thermosetting plastic it would presumably be possible to thicken the section sufficiently to provide well-radiused angles although at the expense of nesting, which must inevitably suffer as the depression shown in the original design becomes clogged with dirt.

These arguments on the other side of the case are put forward, not because I am in any way prejudiced against plastic products, but in the interests of appropriate design. My purpose is to point out the danger of spoiling a case by overstatement, and to remind manufacturers that although plastic articles *can* be made in the shape of almost any article

normally made of more traditional materials, other factors in addition to this remarkable versatility have to be taken into account. I should also like to add that I entirely agree with the remarks in your editorial under the heading "The Search for Novelty."

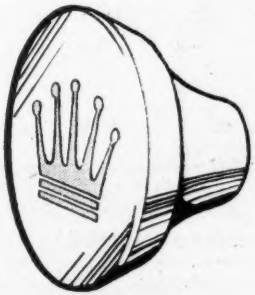
At the beginning of this letter I referred to the fact that plastic materials are not as new as they are assumed to be in some quarters; I will end by remarking that the efforts to improve the design of plastic products dates back quite a while. A plastics committee was set up by the Council for Art and Industry, under the chairmanship of the late Frank Pick, some 10 or 12 years ago, but there is still room for development, and the Council of Industrial Design is most anxious to collaborate.

N. E. KEARLEY, deputy director,
Council of Industrial Design.

Tilbury House,
Petty France, S.W.1.

Filling Compounds

Sir,—From time to time we require a colour compound for filling lettering and motifs in cellulose acetate mouldings. The accompanying sketch shows a typical example of our products. The knob is a white acetate moulding, and the crown is recessed, and is to be filled in blue.



Up to the time of writing we have had very little success in finding a suitable compound which is easy to handle, dries quickly, and provides a bright finish. Would you let us know of any firms who might produce this sort of material? Or, failing this, any information on the compounding of a filling would be most welcome.

AC-SPHINX SPARK PLUG CO.
Dunstable, Beds.

[EDITOR'S NOTE: Filling compounds are usually special waxes, suitably coloured, which are pressed into the recess and the excess then wiped off. Obviously, the process is not always successful, since the wax can shrink and fall out (especially where the recess is not undercut or gives no key). An entirely different process was that of keying metal inserts by the Chilton process of the U.S.A. Yet another method is that of The Superb Stamping Co., of 84, Highbury Park, London, N.5 (see "Plastics," June, 1947, p. 326.)]

Plastic Stoppers

Sir,—We have been endeavouring for some time to find a manufacturer in this country capable of offering the following items, which we require for export to the Dutch market:—

(1) Plastic stoppers for auto-battery containers. These stoppers should be provided with a screwing thread.

(2) Plastic screwing stoppers. These stoppers are to be applied in five-centimetre thick concrete plates.

Assistance in contacting likely manufacturers will be appreciated.

A. JOHNSON AND CO. (LONDON), LTD.
Africa House, Kingsway, W.C.2.

TRADE INQUIRIES

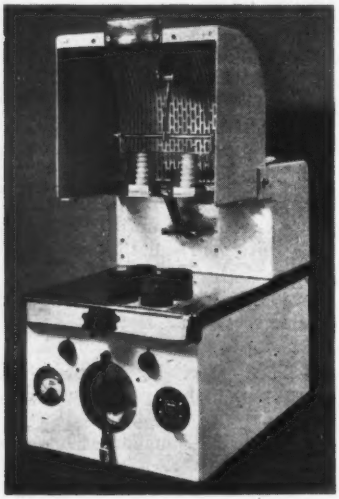
Luminous Sheets ("Plastics," November, 1947, p. 599).—Gilbert Galea, Dominion House, Bartholomew Close, London, E.C.1, writes to say that he acts as stockist and distributor for Catalin, Ltd., who are the most likely source of supply of luminous plastic sheets.

"Plasknit." — Scholefield, Goodman and Sons, Ltd., 23, Lime Street, London, E.C.3., have received inquiry from New Zealand for a line of material known as "Plasknit" and would like to contact manufacturers. The sample they submit is in the form of "plastic wire."

PRODUCTION NEWS

Raw Materials, New Plant, Works Organization, Control Apparatus, Research, Personal and Trade Notes

NEW RADIO HEATER.—To meet the demand for small high-performance table equipment, a new model has been added to the range of pre-heaters made by Radio Heaters, of Wokingham, Berks. This new equipment (Radyne H4/A) gives an output of some 25 B.Th.U. per minute. The base of the oven on which the plastic powder or



preforms are placed is a chromium-plated platform measuring 14 ins. by 12 ins. It is necessary only to close the oven lid in order to start the heating process, the duration of which is preselected on an automatic full-vision timer. At the end of the heating cycle the oven lid opens automatically. The equipment will plasticize up to 6 oz. of moulding powder per minute. Overall dimensions are 14 ins. wide by 21 ins. deep by 20 ins. high. The demand for a very small equipment will shortly be met by the introduction of a heater which will plasticize up to 2½ oz. per minute.

PRECISION TIMER.—A self-contained interval timer for giving a visible signal at the completion of any time interval from a few seconds to a maximum of 15 minutes is obtainable from Turner Manufacturing Co., Ltd., Villiers Street, Wolverhampton. Its uses include the precise timing of plastic moulding operations. The instrument is operated by a synchronous motor (200-250 volts, single-phase, 50 cycles supply), which is started and stopped automatically. It is made as a wall-mounting model and also for panel mounting. The pointer of the instrument is normally in the zero position. To start the timer it is necessary only to turn this pointer, by means of a knob, to the time interval desired. Setting the interval starts the motor simultaneously and illuminates the indicator lamp. The pointer moves back until it reaches the zero position, at which point the indicator is extinguished and the motor immediately switches itself off ready for further use.

STEAM BOILER ECONOMY.—The high cost of fuel, which is likely to be a permanent feature of our industrial economy, coupled with shortage of supplies, makes efficiency in the use of fuel imperative. Efficient generation of steam used for power or process work is also likely to improve production in the works, with consequent increased output and reduction in manufacturing costs. Any measures that can be taken to that end will, therefore, be to the financial advantage of the user. The charts now published by the British Standards Institution in B.S.1374 (log sheets for steam boiler plants) have been prepared to help those who have not hitherto kept adequate records. Used systematically and regularly, and if submitted to careful examination each day by some responsible person, they should go far towards ensuring a regular increase in the quantity of steam produced from each pound of coal put into the boiler furnace. Supplies of log sheets for regular use can be obtained from the British Standards Institution, Sales Dept., 24, Victoria Street, London, S.W.1.

STANDARD BOBBINS.—Fraser and Glass, Ltd., Woodside Lane, London, N.12, have published a special pamphlet on standard electrical bobbins. This company, which produces over 10,000,000 of these bobbins per year, possesses a large number of moulds and is rendering the electrical industry a signal service by this action. In their pamphlet over 80 bobbins, square, round

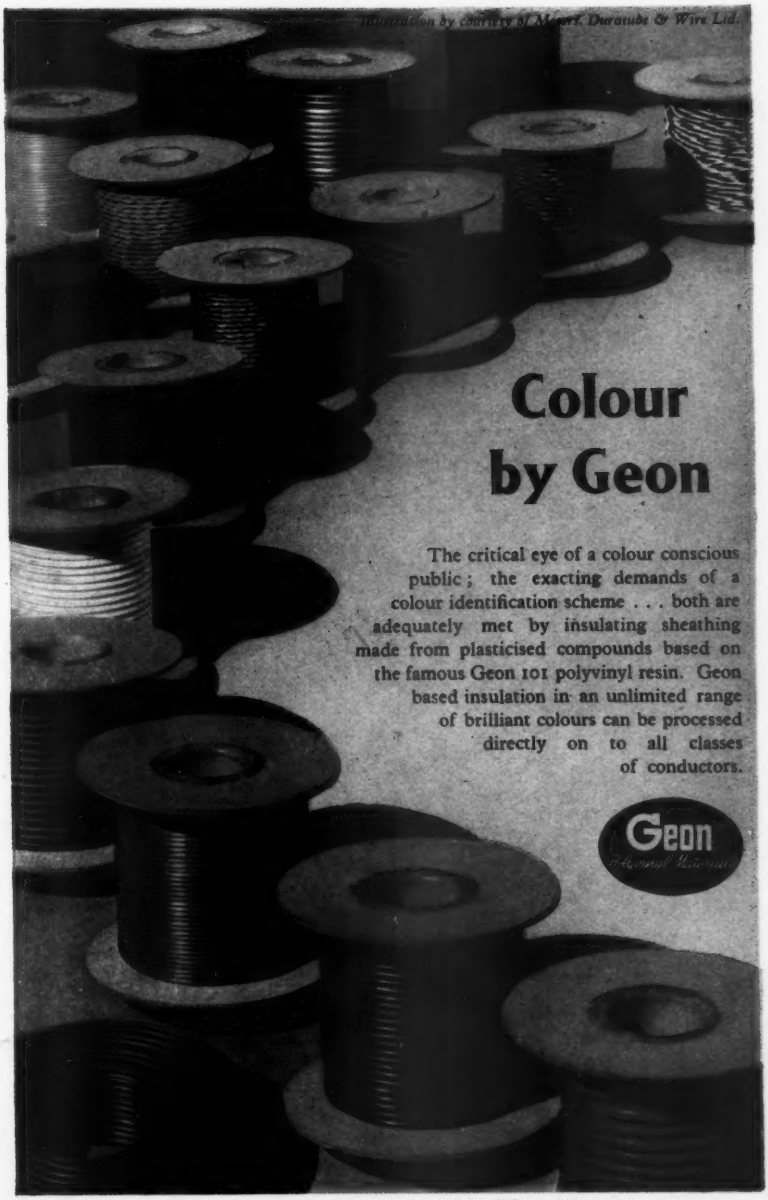


Illustration by courtesy of Messrs. Dunlop & Wire Ltd.
Colour by Geon
The critical eye of a colour conscious public; the exacting demands of a colour identification scheme . . . both are adequately met by insulating sheathing made from plasticised compounds based on the famous Geon 101 polyvinyl resin. Geon based insulation in an unlimited range of brilliant colours can be processed directly on to all classes of conductors.
Geon

British Geon Limited

Sales Office: Abbey House, Baker Street, London, N.W.1. *Telephone:* Welbeck 2332/6

Feeding Industry

Peter Merchant Limited

Caterers to Industry

HEAD OFFICE · 5 TILNEY STREET · LONDON · W·1

Telephone : WELBECK 8311

and telephone types, in thermoplastic and thermosetting resin, are carefully tabulated as to reference numbers, core, flange and body dimensions. The bobins can be supplied in large or small quantities, without tool charges.

NEW PLASTICS INTERMEDIATE.—The successful completion of research work on β-propiolactone, a new intermediate of interest to the plastics industry, has been announced by B. F. Goodrich Co., and manufacture has been commenced on a small scale. The new intermediate is made from ketene and formaldehyde. Besides making possible the production of a new range of chemicals, β-propiolactone promises to open up new and cheaper methods for basic materials already used in the plastics industry. It will find outlets for the production of thermo-setting resin products which are likely to be tougher and less brittle than existing examples; also in the form of new polymerizable esters and "polyblends" in which American rubber and plastics are blended.

ENGINEERING WITH RUBBER.—Various aspects of the use of rubber are reviewed in "Rubber Developments" (Vol. 1, No. 1), published by The British Rubber Development Board, Market Buildings, Mark Lane, London, E.C.3. An article by J. P. Lawrie, under the title "Engineering with Rubber," illustrates a resilient mounting for carrying the propeller-shaft centre bearing of a heavy motor vehicle, V-couplings as used in motor generator sets, and mounting applications. Other articles deal with liquid latex, latex processes and potentialities (W. H. Stevens), "Positex," and the United States rubber policy. The article on latex processes includes a useful list of patents from 1922 to 1944.

BRITISH RUBBER DEVELOPMENT BOARD have changed their address to Market Buildings, Mark Lane, London, E.C.3. (Telephone, Mansion House 9383.)

O. AND M. KLEEMANN, LTD., have announced a final dividend of 150 per cent., making 270 per cent., less tax, for the year to August 31. For the previous year the distribution was 80 per cent., less tax, comprising an interim of 30 per cent. and final 50 per cent. The preliminary statement shows that after deducting £290,033 (£202,822) taxation the net profit is £214,554 compared with £62,239. General reserve is allocated £50,000 (nil), and the sum of £32,970 (£29,291) is carried forward. The issued capital of the company is £100,000.

R. H. COLE AND CO., LTD.—Mr. G. W. Brown, who joined the company in 1937, has now been appointed to a seat on the board; for several years he has been general manager of the company, which has lately increased its scope in the supply of raw materials for the plastics and paint industries.

R. A. BRAND AND CO., LTD., of Pendleton, Manchester, whose activities have lately been extended to cover the development of "Cocoon" protection for industrial equipment, announce that Mr. S. Spencer has been appointed general sales manager as from December 1. Mr. Spencer is already well known in the packaging field as sales manager of British Cellophane, Ltd.

MR. G. HAIM has left Rockweld, Ltd., Croydon, and is now associated with Rediffusion, Ltd.

MR. D. ST. AUBYN BUTCHER, A.M.I.Mech.E., A.M.I.E.E., has taken up an appointment with Indestructible Paint Co., Ltd., as manager of their Electrical Insulating Division.

NOTES FROM BRITISH PLASTICS FEDERATION

New members.—The following have recently been elected to membership of the Federation:—

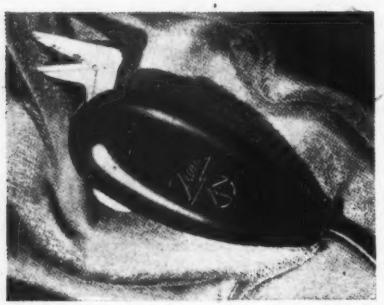
MOULDERS' GROUP:
Plasticraft, Ltd.

FABRICATORS' GROUP:
Macanie (London), Ltd.

New Section.—The P.V.C. Fabricators' Section has now been formed to cover the interests of manufacturers engaged in the fabrication of articles from p.v.c. sheeting. Two meetings have been held, and active steps are being taken to work out a scheme for the marking of quality goods.

Buyers' Guide.—This is being prepared by the Moulders' and Fabricators' Groups, primarily for overseas circulation. Entries in the guide are restricted to the products of members of the Federation, but a large number of entries are expected to be inserted. It is hoped that it may be possible to have the guide available in time for the 1948 British Industries Fair.

New Productions from the Moulding Shops

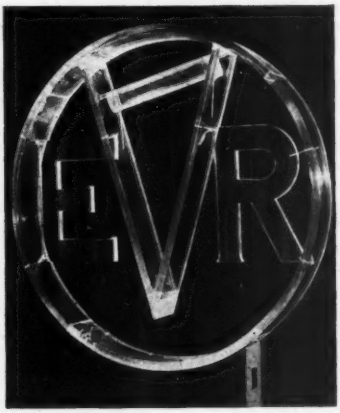


Electric Scissors

The electric scissors illustrated are of American origin (Atlas Instrument Co.). The steel cutting-blades are driven by a vibrator-type motor which is housed in a phenolic case designed to fit the hand. (Acknowledgments to Durez Plastics and Chemicals Inc., North Tonawanda, N.Y.)

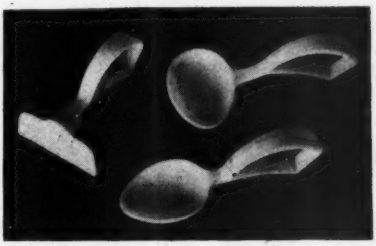
Cycle Lamp

We have received the latest example of the work of Zinnie Products, 125, High Street, Bromley, Kent. It is a lightweight bicycle lamp (2¼ ounces), the whole of the body and "glass" being pressed from cellulose acetate sheet. It will also be seen that the fixing lug is not a separate structure, but one with the body.



Advertising Sign

This advertising sign was seen at "Radiolympia," on the stand of The Erie Resistor Co. It is executed in "Perspex," 1 in. thick by 6 ins. wide and measures 4 ft. in diameter. The material was edge-lit, with changing colours. The sign was made by Plexi Products, Ltd., Burlington Road, Fulham.



Spoon and Pusher

Ornia, Ltd., 50, Station Road, London, N.W.10, are now making plastic spoon and pusher sets for tiny tots who are starting to acquire good table manners. The "Baba" spoon and pusher are extremely well moulded in cellulose acetate, which is claimed to be medically approved, pastel shades being available apart from a pleasing cream colour. The design is well proportioned, and the spoon is made in two shapes, as seen in our illustration.

PATENT REVIEW

The following abstracts have been made from specifications at the Patent Office, with the permission of the Controller of H.M. Stationery Office. Complete specifications can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.

B.P. 591,135. Application date: 31.1.40. Convention date (France): 2.2.39. Accepted: 8.8.47.

Rigid Moulded Articles with Great Tensile Strength. To: Compagnie Générale d'Electricité.

Reinforcement of moulded articles by incorporating not less than 30 per cent. by volume of artificial inorganic threads (glass, silica, quartz or metal).

B.P. 591,137. Application date: 5.2.44. Accepted: 8.8.47.

Improvements relating to Structures comprising Iso-olefindiolefin and like Interpolymers and other Rubber-like Materials. Communication from Standard Oil development Co.

Low temperature bonding of a copolymer containing a major proportion of an iso-olefin (isobutylene) and a minor proportion of a polyolefin (butadiene, isoprene, piperylene, etc.) to steel, rubber, etc., by providing a layer of said copolymer containing up to 225 parts by weight of carbon black per 100 parts of copolymer and a layer of adhesive to bond together the solid substance and the carbon black particles at the surface of the copolymer layer. Examples of adhesives: Vulcalock (sulphonated rubber), Bostick M 35, Reanite, etc.

B.P. 591,161. Application date: 27.4.45. Convention date (U.S.A.): 4.5.44. Accepted: 8.8.47.

Improvements in or relating to the Preparation of Moulding Materials. To: Bakelite, Ltd.

Preparation of a mouldable composition by incorporating with a mixture of liquid or powdered thermosetting resin and filler a proportion of a substantially non-solvent wetting liquid (water or a non-solvent hydrocarbon) working the mixture to form beads or pellets and driving off the wetting liquid under conditions which preserve the pellet form.

B.P. 591,184. Application date 30.4.45. Convention date (U.S.A.): 31.3.44. Accepted: 11.8.47.

Improvements in Manufacture of Fibrous Sheet Material. Latex Fiber Industries, Ltd.

Claims a fibrous sheet material having deposited on its fibres prior to forming into a web a copolymer of butadiene-1,3 and styrene. The fibrous sheet consists of 3-100 parts of copolymer per 100 parts per weight of the fibres.

B.P. 591,221. Application date: 16.3.44. Accepted: 12.8.47.

Improvements in and relating to Methods of Preparing Silicone Resins. To: The British Thomson-Houston Co., Ltd.

B.P. 591,248. Application date: 3.5.45. Accepted: 12.8.47.

Improved Process for the Production of Tri-isobutylene. A Communication from the Standard Oil Development Co.

B.P. 591,303. Application date: 4.5.45. Convention date (U.S.A.): 5.5.44. Accepted: 13.8.47.

The Manufacture of New and Improved Resol Compositions. To: E. I. Du Pont de Nemours and Co.

Production of resols from methylol aminotraizines and N-methylol derivatives of aliphatic diureas.

B.P. 591,335. Application date: 29.5.45. Convention date (U.S.A.): 27.5.44. Accepted: 14.8.47.

Improvements in the Catalytic Polymerization and Interpolymerization of Ethylene. To: E. I. Du Pont de Nemours and Co.

Polymerization of ethylene in the presence of tertiary butyl hydroperoxide as catalyst.

B.P. 591,372. Application date: 4.5.45. Convention date (U.S.A.): 9.5.44. Accepted: 15.8.47.

Adhesive Sheets. To: Johnson and Johnson (Great Britain), Ltd.

Adhesive sheets consisting of a flexible porous backing, an adhesive layer and a flexible intermediate barrier coat. This barrier coat contains a synthetic rubber (GR-I, GR-M, SR-A, GR-N, or GR-S), fillers (calcium carbonate, clay or zinc oxide) and a compatible resin (rosin or a courmarone-indene derivative).

B.P. 591,402. Application date: 8.7.44 and 18.10.44. Accepted: 18.8.47.

Improvements in or relating to the Manufacture of Capsules Containing Liquid. K. Posner.

Apparatus for manufacturing and filling containers made from thermoplastic

materials by extrusion (tubes) and means for subsequent heat sealing under pressure.
See also B.P. 591,442.

B.P. 591,403. Application date: 2.8.44. Accepted: 18.8.47.
Improvements in or relating to the Manufacture of Flexible Material Comprising a plasticised Thermoplastic Substance and Fibres. F. H. Lane. To: Dunlop Rubber Company, Ltd.

B.P. 591,442. Application date: 18.10.44. Accepted: 18.8.47. Divided out from B.P. 591,402.
Improvements in or relating to the Manufacture of Capsules containing a Liquid. K. Posner.
Similar to B.P. 591,402, but manufacture of the capsules in this case starts with prefabricated tube.

B.P. 591,444. Application date: 13.1.43. Convention date: (U.S.A.) 14.1.42. Accepted: 19.8.47.
Improvements relating to the Curing of Polymeric Materials. To: Standard Oil Development Co.
Curing of rubber-like copolymers of iso-olefins and diolefins prepared by low-temperature polymerization by heating the copolymer in admixture with a quinonoid substance (paraquinone dioxime, quinone, tetrabromoquinone, p-aminophenol, p-phenylene diamine, alpha naphthylamine, etc.) with or without an oxydizing agent.

B.P. 591,457. Application date: 26.7.44. Accepted: 19.8.47.
Method of and Means for Thermally Plasticizing Thermoplastic Materials. H. C. Young.
Refers to means and equipment for infra-red heating of thermoplastics prior to forming.

B.P. 591,479. Application date: 1.5.45. Accepted: 19.8.47.
Improvements in and relating to Articles of Bonded Wood Laminae. B. Jablonsky.

B.P. 591,496. Application date: 3.7.44. Convention date: (U.S.A.) 16.3.43. Accepted: 20.8.47.
Manufacture of Resinous Condensation Products. To: Monsanto Chemical Co.
Relates to the manufacture of amino-triazine-aldehyde condensation products modified by a mono-amino-diphenyl.

B.P. 591,515. Application date: 7.5.45. Convention date: (U.S.A.) 12.5.44. Accepted: 20.8.47.
Improvements in or relating to Adhesive Compositions. To: E. I. Du Pont de Nemours and Co.
Adhesive compositions comprising a completely or partially hydrolized interpolymer of ethylene and vinylacetate, a methylene donating agent (formaldehyde) and an acidic catalyst (a carboxylic acid).

B.P. 591,590. Application date: 25.9.44. Accepted: 22.8.47.
Improvements in or relating to the Insulation of Electric Wire and Cable by Extrusion. J. McConnochie Keenan. To: Standard Telephones and Cables, Ltd.
Refers particularly to equipment for the manufacture of a coating carrying a multi-coloured pattern.

B.P. 591,592. Application date: 25.10.44. Convention date: (U.S.A.) 25.10.43. Accepted: 22.8.47.
Improvements in or relating to the Scratch Resistance of the Surface of Methyl Methacrylate Polymer Articles. To: Imperial Chemical Industries, Ltd.
Process for improving the scratch resistance of polymethyl methacrylate by coating its surface with a solution of hydrolized ethyl silicate and hydrolized vinyl acetate, drying of the surface film and pressing it subsequently against a hard surface to effect bonding under simultaneous application of heat.

B.P. 591,616. Application date: 14.5.45. Accepted: 22.8.47.
Improvements in or relating to the Printing of Continuous Films of Water-sensitive, Organic, Non-fibrous Materials. W. Berry. To: British Cellophane, Ltd.

B.P. 591,627. Application date: 29.3.44. Convention date: (U.S.A.) 1.4.43. Accepted: 25.8.47.
Improvements in or relating to Synthetic Rubber Compositions. To: The British Thomson-Houston Co., Ltd.
Curing of butyl rubbers containing p-quinone dioxime, a peroxide, sulphur and a compound of the class consisting of thiurams and diothiocarbamates.

B.P. 591,636. Application date: 21.12.44. Convention date: (U.S.A.) 30.12.43. Accepted: 25.8.47.
Improvements in or relating to Method and Apparatus for Automatic Moulding of Plastics. To: Bakelite, Ltd.
Moulding equipment incorporating means for high-frequency heating of the mouldable plastic between loader and moulding press.

B.P. 591,687. Application date: 3.5.45. Convention date: (U.S.A.) 6.10.44. Accepted: 26.8.47.

Improvements in or relating to Methods of Setting Knitted Fabric Articles comprising Synthetic Linear Condensation Polyamide Fibres. To: Paramount Textile Machinery Co.

B.P. 591,721. Application date: 7.2.45. Convention date: (U.S.A.) 6.6.44. Accepted: 27.8.47.

Suspension Polymerization. To: Röhm and Hass Co.

Polymerization of a monomeric, water-insoluble, ethenoid material (vinyl chloride or mixtures of vinyl chloride and vinyl-acetate, or mixtures of ethylacrylate and methyl methacrylate) dispersed in water, employing as dispersing agent a hydrous complex magnesium silicate which swells in water and forms gels.

B.P. 591,738. Application date: 12.5.45. Accepted: 27.8.47.

A Tool for Localized Electric High-frequency Heating of Insulating Materials. J. C. Quayle and P. Jones. To: British Insulated Cables, Ltd.

High-frequency hand tool suitable for spot welding or spot gluing.

B.P. 591,742. Application date: 14.5.45. Accepted: 27.8.47.

Improvements in a Tape Container. To: The Scholl Manufacturing Co., Ltd.

Tape container, including a plastic spool upon the barrel of which the tape may be wound and a transparent or substantially transparent cover of plastic material removably associated with said spool.

B.P. 591,749. Application date: 15.5.45. Accepted: 27.8.47.

An Improved Method of and Apparatus for Manufacturing Containers from flexible Sheet Material. E. K. Buxbaum. To: Bee Bee Biscuits, Ltd.

Method and apparatus for the manufacture of cellulose acetate containers, providing means for folding, filling, labelling and heat sealing.

B.P. 591,771. Application date: 15.5.44. Accepted: 28.8.47.

Improvements in and relating to 2-Halogenœthoxy Silicon Compounds. To: The British Thomson-Houston Co., Ltd.

B.P. 591,782. Application date: 14.9.44. Accepted: 28.8.47.

Improvements in or relating to Boxes and like Receptacles and Containers. J. Veit and J. F. Kenure.

Box moulded from a thermoplastic resin consisting of a rigid receptacle, a rigid lid and a flexible hinging web.

B.P. 591,787. Application date: 9.10.44, 8.2.45, 11.7.45. Accepted: 28.8.47.

Improvements in and relating to Plasticizing, Reclaiming or Reworking Vulcanized Rubber. To: D. Gestetner, Ltd.

B.P. 591,810. Application date: 25.7.44. Convention date: (U.S.A.) 26.7.43. Accepted: 29.8.47.

Improvements in and relating to Methods of Preparing Organosilicon Chlorides. To: The British Thomson-Houston Co., Ltd.

B.P. 591,820. Application date: 24.1.45. Accepted: 29.8.47.

Improvements in or relating to the Production of Regenerated Cellulose Sheet Wrapping Materials. W. Berry and C. R. Oswin. To: British Cellophane, Ltd.

Sheet wrapping material having mould-inhibiting properties due to the incorporation of a monohydric chloror bromphenol of the benzene, toluene, xylene or cymene series.

B.P. 591,863. Application date: 18.8.44. Accepted: 1.9.47.

Improvements in or relating to the Production of Vinylidene Choride Copolymers. J. J. P. Staudinger and D. Faulkner. To: The Distillers Co., Ltd.

Refers to vinylidene-isobutylene copolymers.

B.P. 591,899. Application date: 8.8.44. Accepted: 2.9.47.

Improvements in or relating to a Method for Riveting Thermosetting Resinous Materials. J. H. Paterson, H. P. Zade and G. Haim.

Riveting together sheets of thermosetting plastics by means of rivets made of thermoplastic material. The heating of the rivets is carried out by a high-frequency gun.

B.P. 591,909. Application date: 8.11.44. Accepted: 2.9.47.

Improvements in Composite Bonded Sheet Insulating Materials. To: Mica Patents Trust (U.S.A.).

Composite mica insulation capable of resisting high temperatures, bonded by ethyl silicate and polyvinyl acetate, polyacrylate or polystyrene.

The Microscopic Examination of Plastic Materials

VI.—Mouldings (Fillers)—(f) Fibrous Materials (Contd.)

By J. H. WREDDEN, F.R.M.S.
(Chief Chemist, Igranic Electric Co., Ltd.)

IN concluding this section on fibrous fillers it is proposed to continue our examination of the monocot fibres by taking Florida sisal as the next example. The sisal fibres have been dealt with in some detail by reason of their great commercial importance, and the possibilities offered by processing waste as potential sources of supply for filling materials.

It was pointed out, when dealing with Agave cantala, that the sisal fibres are all very similar in structure. Whereas this is mainly true, there are slight differences which, however, would not be expected to have any very great influence on the utility of the fibre as a filler. It will have been noticed from our study of these fibres that, in contradistinction to the esparto fibre, the sisal does not appear to exhibit the presence of the cross markings in any form, and from this aspect alone there is a sharp distinction among the monocot fibres which is worthy of note.

Sisal, as cultivated mainly along the Florida coast, possesses the usual characteristics of sisal in general. Florida sisal, however, is the best known and most widely used of the sisal fibres. The examination of the material in transverse section is important. Fig. 240 shows a photomicrograph of this fibre at a magnification of 100 diameters. The actual fibre is seen in the area marked A; the structure outside this area is that of the matrix in which the fibre was embedded, and should be ignored.

From the structure of the fibre itself we see that it is part of a typical monocot vascular bundle, and at the point B we see a group of smaller vessels, while at C there appears a large vessel, as may be expected to be found in a structure of this kind. The remainder of the fibre consists of a large number of phloem elements, which makes clear one of the reasons for the great strength of this material. These elements are generally possessed of quite thick walls, although in a number of cases the lumen is large, as, for example, in the case of the element marked D and its immediate neighbours. It will also be noticed that the lumen in these elements is nearly circular or, rather, less distorted than those of the more peripheral elements in that section of the fibre marked E, where the bores are seen to be considerably distorted. This condition is, of course, similar to that met with in the case of esparto grass, where the effect of growth and stresses

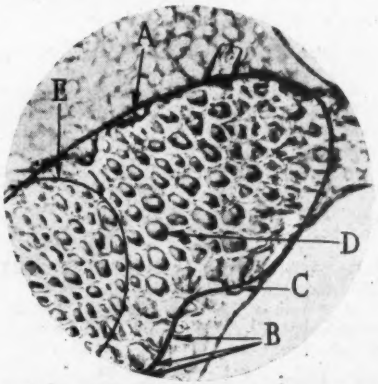
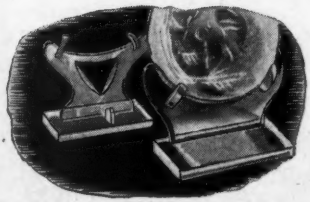


Fig. 240.—Sisal fibre, transverse section. Mag. 100 diameters.



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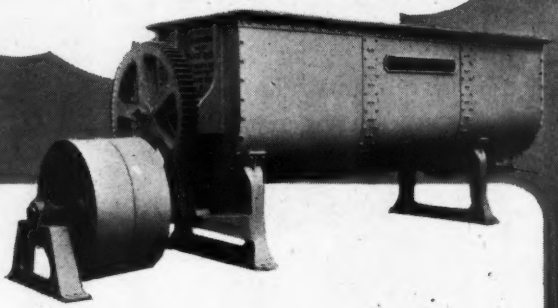

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on the peripheral elements of the fibre was very marked.

In spite of this discrepancy in the lumen morphology, the wall thickness of these elements will be seen to be very regular, thus the cell walls of the peripheral elements are the same thickness as those more centrally placed. One of the most interesting features of this fibre lies in the great difference existing in the size of the bores, for it can be seen that in some cases the lumen is so small as to be almost non-existent, whilst at the other extreme their size is self-evident.

In summarizing the general morphology of this structure, it becomes evident that the fibre, as used in commerce, derives its great strength from the very high proportion of phloem tracheids present, which when considered collectively are capable of producing a structure of great strength. The manner in which the elements are fitted together to obtain this result is shown in Fig. 241, this being a photomicrograph of a portion of the same section at a magnification of 310 diameters. From this photomicrograph it becomes apparent that the regular wall thickness is very well maintained, even in the case of those units which are very small.

The presence of what appears to be a 'median layer" between adjacent fibres will also be noticed, but as the existence of this does not seem to be universally accepted as fact, this conclusion must be modified to some extent. Indeed, it is possible that no median layer exists in this instance, the appearance of the section being due possibly to optical phenomena, or the existence of some material other than lignin. However, it may be taken that the elements are capable of being separated easily by the usual alkaline treatment. If the "median layer" does exist, then it would appear likely that lignin is present in only small amounts; but whatever the material, the fact that it is possible to break the fibre down into its component elements without greatly damaging these latter, would point to the existence of a layer of some cementing material. Alternatively, the

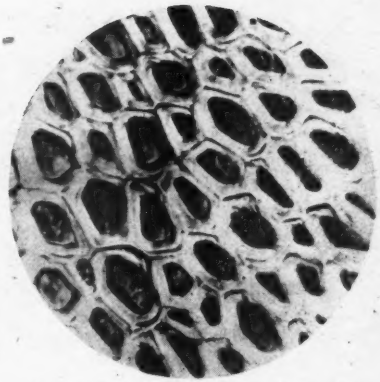

Fig. 241.—Sisal fibre, transverse section, showing median layer. Mag. 310 diameters.

structure of the fibre would consist of the elements being held together by material of the same nature as themselves, and hence under the action of solvents the elements themselves would also suffer.

When regarded from the point of view of utility as a raw material for fillers, we are obliged to conclude that sisal fibre would be of greatest use when cut up into very short lengths, because of its strength when in this condition. It will also be appreciated that a process which is capable of doing this successfully would produce a material of small variability index and good length-to-breadth ratio, so far as particle characteristics are concerned. However, when the fibre is broken down into its elements, the flour so produced would possess an L.B. ratio of about 100. This figure, when taken into consideration with a variability index of the order of 2.6 to 3.0, indicates a flour of considerably greater variation of characteristics than would be the case with a flour produced by the cutting-up method where the variability index may be brought much nearer to unity. It should, however, be remembered that in the latter case there would be some increased difficulty in impregnating the fibre particles due to the variations present in the lumen size of the elements, although this is not a serious difficulty

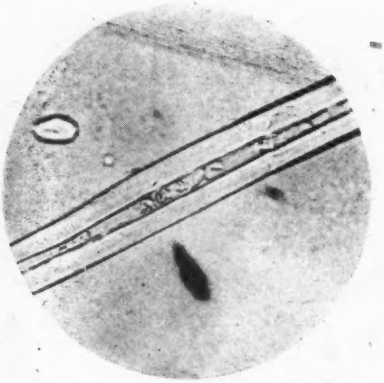

Fig. 242.—Sisal fibre element. Mag. 310 diameters.

with this fibre, yet it should not be entirely ignored.

Having thus examined the fibre in transverse section, let us proceed with a brief examination of the fibre elements. These are generally very similar to those encountered in the case of Agave cantala, although it should be pointed out that in the case of the fibre under examination, there does not appear to be the relatively high percentage of distorted elements present. The elements of Florida sisal, in fact, are remarkable for the consistency of their morphological characteristics when examined in the separated form. The tips, as a rule, are tapered, with only very few individuals exhibiting distortion, either of the cell wall or the lumen; in the case of the latter there seems to be a general tendency for a slight expansion of the bore towards the middle of the element, due to the presence of crystalline bodies in a number of cases.

This effect is well seen in Fig. 242, which illustrates one of these elements at a magnification of 310 diameters. From this photomicrograph it will be seen how the lumen is somewhat expanded in the middle with the bodies which are also visible. It will further be noticed that in spite of this expansion of the lumen the wall thickness has not suffered to any appreciable extent. The increase in size in the bore is followed by a corresponding increase in the external diameter of the fibre and it follows that very little, if any, loss of strength would result from a mild distortion such as this. In the case of the specimen under examination, this type of distortion was the only one encountered, the elements being remarkably even both with regard to their shape and size.

It is probable, therefore, that Florida sisal would make an efficient filling medium if used in the separated condition, that is to say, after chemical treatment separating the elements. The resulting very fine textured material might be expected to possess similar properties, mechanically and electrically, to those exhibited by a cotton flock filler, but without the difficulties attendant on this latter, in so far as its incorporation into the resin is concerned. The fibre elements are much shorter and somewhat stiffer than the cotton fibres, and would not tend to "ball up" so readily in the mixing, which should in consequence be more easily controllable.

This question of the form in which the fibre is of the greatest use, requires further examination when its possibilities in the "cut up" form are considered. Hitherto this method of utilizing fibres has been suggested, but the difficulty of producing a fibrous flour by mechanical reduction so that the product consists of very short lengths of the whole fibre, has also been pointed out. It was further suggested that this was by no means insurmountable, and in order to demonstrate the type of product thus obtained, it is proposed to examine briefly a flour produced from sisal fibre.

As may be expected with such a material, a flour produced from the commercial fibre must of necessity contain a certain amount of extraneous material. In Fig. 243 is seen a photomicrograph of some Florida sisal which has been reduced to flour form by what virtually amounts to a grinding operation. The flour produced was relatively coarse, being classed as about 40 to 60 mesh, hence the particles are large. From the

photomicrograph it will be seen that there is extraneous matter present in the form of masses of soft tissue cells, such as that shown at A.

The sample examined exhibited the presence of this tissue in the form shown to the extent of some 7 to 10 per cent. of the total volume of clean fibre, but apart from this type of impurity the flour was remarkably free in this respect, dust and other fine matter being so small in amount as to be negligible. This was put down to the fact that many of the fibre particles still had an appreciable quantity of soft tissues adherent, in spite of having been through the reducing process. From this aspect alone, it would appear that for successful conversion to filling materials fibres in general should be as clean as possible; this does not mean to say that there must not be any soft-tissue material present at all, as this obviously would put the cost of the raw fibre at such a high level as to make its use prohibitive. Rather would it suggest that a small proportion of soft tissues may be tolerated in view of the possibility of their surviving the reduction of the fibre without being detached and so becoming a free impurity, thus rendering them much more effective as such.

In connection with this, it should be remembered that if the extraneous matter exists as free particles, then they will function as poor filler particles in the finished mouldings and exert their full detrimental effect. On the other hand, in those cases where the undesirable material still remains a part of the desired particle, then the only effect produced will, in all probability, consist of a slight reduction of the effective function of this latter, which, in the majority of cases, may possibly be ignored.

The difficulty lies in determining what proportion of soft tissue is allowable in any given fibre, because, as this proportion is reduced, so does the cost of the fibre increase; as the proportion is increased, so does the efficiency of the filler decrease. Thus, it would appear as

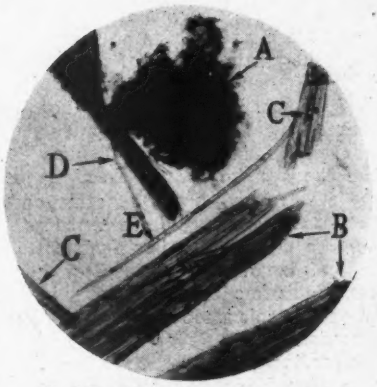

Fig. 243.—Ground sisal flour, general character. Mag. 40 diameters.

if it might be necessary to strike a compromise in this direction, so that the best material is obtained under the economic considerations currently ruling the conditions, for it is clear that in these circumstances the major factor is the cost of the fibre.

Apart from these considerations, the flour proved to be of quite good quality in so far as particle dimensions are concerned. It was found that the material could be analysed into two major fractions, apart from the extraneous matter, these consisted of particles of the whole fibre about 1 to 2 mm. in length and 250 to 400 μ in breadth, such as those shown at B. In the illustration only a portion of the particles are shown, as they were too long to fit into the field at this magnification. The other fraction consisted of shorter portions of fibres, such as those illustrated at C; these varied in length from 100 to 500 μ and were composed of portions of the whole fibre, which had not only been cut shorter than normal across their width, but also subjected to reduction in their length, thus causing the particle to be composed of fewer elements than the whole fibre.

As will be seen from one of the C particles, there are also distinct signs of defibration of the ends of the particle. This, however, is better seen from the

particle marked D, which shows how three fibre elements have been stripped from the main body of the fibre. Particle D, one of a few encountered in this specimen, is narrower than those in the fraction containing the large particles, although this dimension was so much less than the average for the fraction, the length was very much the same and, therefore, these may be considered as a sub-division of the major function; as they only amounted to some 3 or 4 per cent. of this fraction, their number in the flour as a whole is too small to be of any great significance.

Regarding the larger elements, there are signs of apparent defibration commencing, and due to the nature of these fibres. It seems likely that this is initiated in the first instance by the particle splitting off a considerable portion of its bulk longitudinally, as can be seen in the larger of the two particles marked B. This, presumably, would be followed by further longitudinal splitting-off of the elements, either singly, as in the case of the D particle, or in groups of two or more. This would result in the appearance of single fibrils, such as that at E, which need not necessarily be limited to a constitution of one fibre element, but might be made up of two or three elements, still cemented end to end.

From this it seems likely that, in the ideal case, if the reducing process was carried far enough, the entire flour would consist of these defibrated particles, which would all be more or less the same length. However, in practice it is highly probable that they would be considerably reduced in length, and also an appreciable quantity of dust would be generated, apart from that stemming from the soft tissue. As the flour, in the condition shown, has reasonably good dimensional properties, and also as defibration has already commenced, it would be better to stop at this stage; the dimensional properties would then be such that a strong filler particle is present of such a size as to be capable of producing a well-finished moulding.

Fig. 244.—Ground sisal flour, showing defibration. Mag. 40 diameters.

Furthermore, matters could probably be considerably improved in this respect by proper sieving of the flour, which, in this case, was not so treated, the specimen being taken directly from the mill.

In order to show to what extent defibration of the fibre particles takes place, Fig. 244 illustrates one of the larger particles in this sisal flour, at a magnification of 40 diameters. It will be seen from this illustration how the fibre has been divided along its length prior to the commencement of the separation of the fibrils, which can be distinguished at the tops of the two halves of the fibre proper.

It will be noticed that the defibration of fibre particles is somewhat different from that which occurs in the case of wood flour particles. In the latter instance it will be remembered that the wood particle commenced to defibrate at its ends in a similar manner to fibre, but as the tracheids are short and thin-walled elements, in contradistinction to the fibre elements, which we know to be considerably longer and possessed of much thicker walls, they do not withstand the "splaying out." As a result, they either break off as incomplete tracheids or are separated as individuals, and are seldom to be encountered in an undamaged condition.

On the other hand, in the case of fibre,

we have seen that defibration may be produced in its entirety; that is to say, if at the commencement one element is split off. It is then within the bounds of possibility that the splitting will proceed through the entire length of the fibre particle, thus giving a particle consisting of single elements joined end to end. From this it will be seen that the greater stiffness of the fibre element enables defibration to be taken to a much more advanced stage, if so desired, than would be possible with wood flour.

It is also probable that the tendency for the wood tracheid to break up before being completely separated from the parent body, largely accounts for the production of the relatively high proportion of extraneous dust to be found in the finer meshes of wood flour. Conversely, the clean defibration of the fibre particle presumably accounts for the absence of such dust, although it should be borne in mind that, as yet, the opportunity of examining ground fibres in the fine meshes of flour has been lacking. Therefore any assumption regarding the presence or absence of extraneous dust is in the nature of conjecture; particularly so in view of the fact that the great majority of commercial fibres contain some proportion of the soft tissues, however small, which, as we know, is a fruitful source of undesirable material in any flour produced from them.

Having thus examined the Florida sisal fibre as a potential material for the manufacture of fillers for moulding powders, we come to the end of the section dealing with fibrous fillers. In summing up the potentialities latent in general, the major factor controlling their use for such a purpose in the plastics industry is their cost. This is high at the present time, but, nevertheless, the investigation into their possibilities was proceeded with in the hope that the information so obtained would be of some value if ever the time arrived when it was decided to use them.

It has been pointed out that in the range of commercial fibres in use to-day there exists some hundreds of different varieties from which to choose. They all possess one characteristic which may be classed as common, this being the elemental phloem tracheid, which, after all, is that portion of the fibre which gives it its characteristics. In the same way as the xylem tracheid may be regarded as being fundamental to the wood structure and to the elemental unit of wood flour, so may the phloem tracheid be regarded as being fundamental to the fibre structure and thus the basic element of fibre flour.

Having established the importance of the fibre element, we have this large range of fibres whose structure is basically the same, but exhibiting differences between various species. In some cases these differences are great, in others insignificant, but the fact remains that they may be regarded as modifying the behaviour of the fibre particle in one direction or the other. Thus the possibilities of producing blends of fibre flours is opened up, and also it would appear highly probable that such flours may be utilized in spite of a high cost, for blending with other fillers, such as wood flour, the object being to produce added strength in the finished moulding.

In general, we have seen that the vegetable fibres themselves are very strong. It was concluded that they would function most efficiently if used in a condition which did not necessitate pretreatment of the fibre, such as would be the case if reduced to elements, chemically. In this latter condition the elements consist chiefly of cellulose, and the extra strength imparted by the lignin is lost. Yet although it was suggested that the element strength in this case could be regarded as being in the neighbourhood of that for a pure cellulose element, such as the cotton fibre, it must be remembered that in the case of the delignified fibre element the walls are so much thicker than with cotton that, taken unit for unit, the treated fibre element may be expected to be appreciably stronger than the cotton fibre.

This gives chemically treated fibre a certain amount of utility as filling

material, where great strength is not required. Colour, however, is of importance, because when reduced to its elements by alkaline treatment, the resultant product is very white and fine in texture, thus making it a useful material for filling moulding powders produced from colourless resins. In general, as the greater quantity of fillers is absorbed by the phenolic industry, where colour is not of such great importance yet strength is all important, fibre flours would be more useful when ground or cut down from the raw fibre direct; in this way full utilization of the great inherent strength of the natural fibre is achieved.

In spite of the greater strength expected of a chopped fibre as a filler, the use of chemically reduced natural fibre should not be ignored in regard to its use in phenolic moulding powders. Among the various forms of natural fibrous materials already in use, based usually on cotton, one of the most popular of these materials is cotton flock, which has been proved to impart greater impact strength and other desirable qualities to the finished moulding. Thus shock resistance is usually anything from 2 to 6 times that of a standard wood-filled powder; mould shrinkage, likewise, is reduced. These factors, of course, depend on the proportion of cotton flock used and the average fibre length of the filler.

As against improvements, however, the bulking factor of the powder is higher, in consequence of which it is not so easy to handle with respect to preforming, etc. At the same time it follows that the longer the fibre length the less the chances of attaining any degree of orientation in the mould, during the flow period; the strength, in consequence, is obtained by interlocking of the fibres, such as it is. From this it becomes apparent that in the absence of orientation the interlocking of the fibres is the major factor, producing strength in the finished moulding.

It will be seen that the degree of interlocking is dependent on chance, there being no means of exerting even partial control over this characteristic. On the other hand, given judicious mould design, there would seem to be inherent possibilities for controlling the flow of material in the mould and thus exercising a certain amount of control over the orientation of the filler particles, provided these latter are of such a nature as to lend themselves to a degree of direction. Thus, by nature, the cotton fibre does not lend itself very well to this process and hence interlocking must be relied upon. In the case of a filler consisting of shorter and stiffer elements, such as obtained from chemically reduced fibres, the increased probability of obtaining better orientation becomes apparent.

The need for this orientation is apparent by the amount of work which has been carried out on the production of fibrous fillers. In order to obtain increased strengths, cotton fillers have been employed which are already partially orientated before incorporation into the moulding powder. These appear in the now familiar form of chopped rag and canvas and also as cut cord. In these cases the filler particle consists of a large number of cotton fibre elements strongly pre-orientated so that they exist in this form in the structure of the finished moulding, which possesses greatly added strength in consequence.

While dealing with this question of mascerated fabric fillers, it should be borne in mind that in dealing with natural fibres, little attention has been paid to synthetic fibres. Thus it is possible to use rayon fabrics made from regenerated cellulose and newer materials based on superpolyamide resins; in fact, a separate field of filler materials exists in this direction, which may be classed as synthetic fibrous fillers.

These latter materials have already been the subject of much development work, hence the somewhat lengthy treatment of the natural fibres, which was done in the hope of stimulating interest in this direction; up to the present time, very little use has been made of them as potential raw materials for filler manu-

(Continued on page 676.)

Quality Control in Plastic Moulding—I

By W. M. HALLIDAY

The object of this new series of articles is to describe the fundamental principles and objects of statistical methods of "quality control" as applicable to plastic moulding manufacture. Descriptions will be given of the ways in which quality control can be established over various forms of moulded article production, showing how high standards of surface finish, dimensional accuracy, size uniformity, reduction of scrap or defectives can be secured and maintained with the minimum amount of component inspection.

IN all economically successful plastic moulded component manufacture the responsible production engineer has to ensure consistent attainment of a large number of varied yet essential requirements, without which either the quality, precision or cost of production of the article will suffer.

At the very outset of production it is vitally important to have a properly designed and constructed moulding tool capable of accurately and uniformly reproducing the desired component. Achievement of this requirement naturally bespeaks considerable designing and tool-making experience of mould constructions, their operation and use. There must also be suitable moulding-machine equipment for use in conjunction with moulds, so that a proper moulding technique can be applied to the process of moulding. Further, it is necessary to have available a well-trained personnel which possesses the requisite degree of practical experience and knowledge of plastic materials, their peculiarities, mould behaviour, and, indeed, understanding the hundred and one points which normally arise in practical moulding operation.

These general requirements are necessary in order to initiate any moulding operation project, but once production of the parts has satisfactorily been commenced, further needs arise, entailing the proper organization of gauging and checking inspection operations in order that the two under-mentioned outstandingly important aims may be achieved:—

(1) The consistently continuous reproduction of sound and dimensionally accurate moulded articles well within the permissible range of size or feature variation afforded by the customer purchasing those articles.

(2) The provision of reliable means and methods whose object will be to ensure detection of every unpermitted variation, fault, error or departure from due accuracy in the moulded product at a sufficiently early stage during production runs, so as to avoid the formation of large quantities of defective or scrapped workpieces, the replacement or correction of which will involve additional unprovided-for expense.

As every production engineer knows, to achieve these two objectives with dependability it is necessary to institute some form of component inspection, and it is precisely in this connection that many plastic moulders encounter their main difficulties. In these days when highly skilled labour is difficult to obtain, it is often something of a problem for the production engineer charged with extensive inspection operations so to organize available unskilled and untrained operatives for this highly important work. The overcoming of these obstacles often offers the greatest scope for the application of quality control methods of inspection, and, indeed, can often provide substantial benefits.

When precision mouldings are under manufacture employing conventional methods of checking, gauging and inspection, to maintain accuracy and quality, the question invariably arises of exactly

how much and what type of inspection has to be afforded to the job.

Many plastic mouldings produced either by the compression or injection process have to be strictly held to some size within fine limits of variation. Such precision-type mouldings may require 100 per cent. inspection in both senses, viz., the checking of every component produced and the gauging of every portion of each component. Such thoroughgoing inspection, however, whilst undoubtedly guaranteeing the correctness and satisfactoriness of the component to the specified limits, may often fail completely to satisfy the requirements stipulated under (2) above.

Especially will this condition be likely to occur in the manufacture of plastic mouldings of very intricate shape requiring close gauging on a number of surfaces, as well as general inspection for finish, weight and other physical features. Such inspection will obviously occupy an appreciable amount of time, often longer than it takes to produce the part itself in the moulding machine. This will result in the lagging behind production of the inspection operation. Thus, over a long production run it is quite possible for the moulding machine output far to outstrip the capacity of the inspection facilities, to such an extent that hundreds, and even thousands, of components await inspection at a given moment. Quite obviously, this sort of thing, in its turn, can entail large quantities of erroneous parts accumulating excessively before reaching inspection and detection.

Then, also, 100 per cent. inspection of this kind is apt to prove extremely expensive, involving, as it will, a large staff, which may be disproportionate to the number engaged in production of the parts. The cost of such inspection will, therefore, be uneconomical.

Particularly will these circumstances tend to arise in respect of injection-moulded articles, where the cycle of operations is extremely rapid, especially when multi-impression moulds are employed. To a lesser extent, this will occur in regard to multi-cavity compression moulds, where, again, the rate of output over a specified period may be large, even though the actual moulding cycle is relatively longer than that of the injection process.

The most usual form of inspection employed consists of a central inspection department, in which checkers and gaugers work continuously inspecting batches of parts brought in at regular intervals from the various machines. Anything less than 100 per cent. inspection checking, even on parts where dimensional accuracy is unimportant and which have chiefly to be of sound surface finish, may often be fraught with some risks, since it will be still more difficult for the inspector to discover errors, etc., in the moulded article, or variations in the mould or machine at the time they develop, and before a large quantity of such faulting parts has been produced.

Some shops employ a system of floor inspection, providing for each moulding machine or press to be visited at certain intervals by patrolling inspectors, who then test and check the batch of articles produced since the last visit. When faulty components are encountered, production may be stopped until a setter has been notified and brought to the machine or mould to make the required corrections. To cover effectively the output from even a few presses or injection machines of the moderately equipped moulding plant by floor inspectors of this kind, generally demands an unduly large number of persons for this work in comparison with the number directly engaged on production, if inspection is not to lag behind production in the manner, and with the results, which have been mentioned earlier.

It will thus be well appreciated that whichever method of inspection is employed it will fail largely to give the production engineer the kind or degree of control over production and variations in the features of the products in his endeavours to achieve uniformity and accuracy within the limits allowable.

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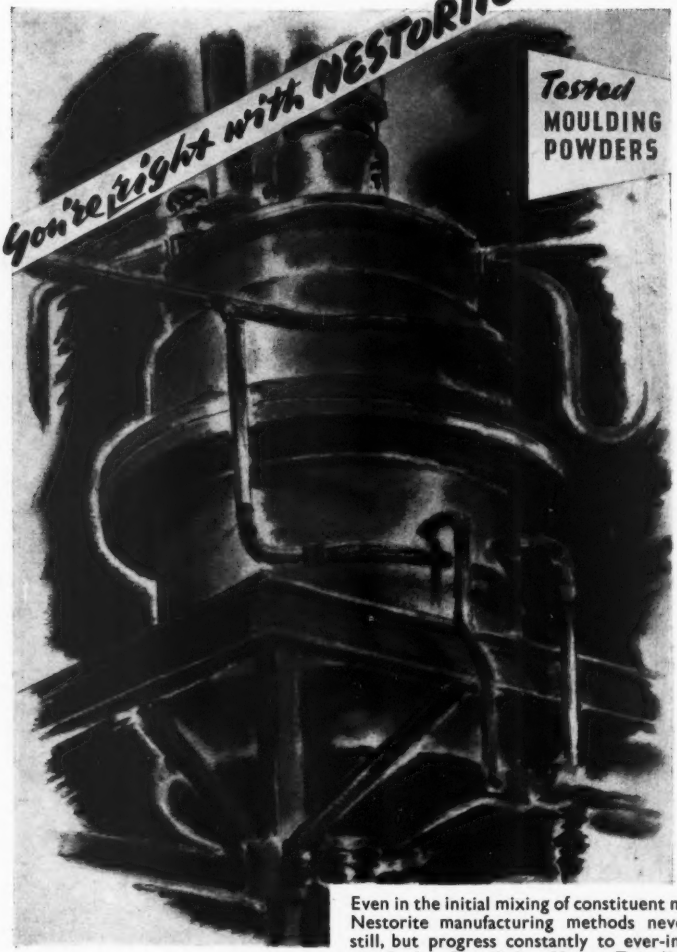

STILL—

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It will be the purpose of this and succeeding sections in this series of articles to describe and illustrate inspection and charting methods of quality control which may successfully be used to overcome the foregoing limitations. A number of simple adaptations of the now well-known principles of quality control will be considered, to show how even the most stringent requirements in connection with gauging and checking of plastic mouldings can easily, reliably, and often less expensively, be secured and maintained than by other conventional methods described. Special reference will be given to ways of applying such principles of quality control to both compression and injection types of moulding, because these usually exhibit the most rapid cycle of operations, as well as the largest number of variable factors likely to affect the quality or accuracy of the finished products.

Fundamental Principles of Quality Control

As an essential preliminary to the discussion upon quality-control methods and its numerous useful applications in plastic-moulding activities, it is necessary to be clear about its underlying principles and objectives in order that the simple rules and general procedure governing the construction, maintenance and interpretation of the various control charts employed (which will be fully described later, may be understood as to their meaning and implications.

Quality control, briefly, is a statistical method introduced for more accurately checking the *trends* and finished results of any machine-made productions, in endeavours to maintain the quality of the article within the range of predetermined permissible scales of variation. It is an improved and more reliable form of process check, employing the aid of pictorial charts so as to depict for ready visual examination and inspection the progress, uniformity and stability of the production operations controlled.

By the application of properly constructed control charts, it is possible to build up an accurate commentary of any repetition machine production, *it being compiled at the same rate and time as the production achieved.* In this way very material contributions towards improved quality, reduction of inspection costs, elimination of defective or scrapped components, can be afforded by the system of quality control.

One of the most valuable features to be derived from its application to plastic-moulding production is that it affords a *simultaneous progressive commentary* upon the behaviour and performance of both machines, moulds, operators and finished plastic mouldings. Since such a commentary check can easily be maintained at the same pace as the rate of production, dangerous and costly lags between inspection and the latter can be avoided.

Quality control, therefore, complements normal inspection methods and directs attention to conditions which develop during production, to the detriment of satisfactory moulding production as these arise, with influence on the quality of the finished products. By means of it, inspection is carried right up to the manufacturing cycle, enabling the following questions to be satisfactorily answered: (a) Can the moulding be produced to the tolerances required? (b) What are the causes for errors and defects likely to cause departures from those limits of variation?

There are three general methods followed in quality-control technique, each of which, of course, has its own special form of application the better to ensure the manufacture of components within the limits of variation laid down. First, there is a statistical analysis made to determine whether the part can be reproduced to the specific tolerances. Secondly, there is the control-chart method, which is specially adapted for application to continuous repetitive production where the components produced have to be held to very close tolerances; this method is very widely adopted.

Thirdly, component inspection by shop-floor inspectors of the first and last-off articles selected at each visitation of the inspector.

These are the chief characteristic objectives of quality control, and it is possible so to adapt one of the three methods just mentioned to cover most plastic moulding operations, which, if applied intelligently and consistently, may be the means of securing many other indirect advantages, as will be explained in greater detail in following sections.

Quality control as an organized system of component check found great favour during the war years, particularly in respect of automatic machine productions, where the rate of output was exceedingly rapid, and the number of factors liable to cause variations in the product was large. Tendencies to vary beyond the limits laid down as permissible for the job were always present, as in plastic moulding, arising from such factors as tool wear, incorrect setting, alteration in tool setting, accurate timing of the machine, its proper adjustment, lubrication, cleanliness, etc., the quality of material employed, and so forth, to mention only a few of the numerous and sometimes inevitable factors which had to be effectively controlled in order to produce stable and uniform features in the produced components.

Types of Machine Production Which Can be Controlled

By applying quality control charts and methods to production conditions such as these, which it is pointed out are very much akin to those appertaining to most forms of plastic moulding, 100 per cent. inspection checks formerly found necessary were eliminated, being substituted by much lower percentage inspections, whilst tendencies towards error inaccuracy and defect were plainly determined and recorded in visual manner on the charts at a very early stage in their development. Thus scrap or costly correction costs for defective workpieces was avoided.

It is often said by plastic moulding production engineers, when considering the merits or otherwise of quality control, that such methods are quite satisfactory and perhaps valuable for use in conjunction with fully automatic machine production upon metallic articles. They are unlikely to prove equally as efficacious in the case of plastic moulding activities, particularly in those forms of compression moulding employing portable and manually actuated moulding tools.

Operation of such moulds entails a relatively large proportion of purely hand work consisting of opening and closing the mould, ejection of the finished parts, cleaning out the cavities before commencing the next cycle, inserting the tool into the press or remove same after cure has been effected. These conditions, it is held, are unsuitable for the application of quality control methods in the manner outlined earlier, because of the notorious liability of operators to err and vary their speed of working, which are, of course, often reflected in the quality and accuracy of the finished moulded article.

This is undoubtedly true of many compression moulding operations, but, withal, the author would urge that these are the very reasons which should lead to the adoption of quality control methods.

It is not a question of being assured which of the plastic moulding activities is sufficiently stable and reliable in practice to warrant placing under the care of quality control methods, but rather which moulding operations are exhibiting excessive variations and instability in their finished products as to render them in need of the help and control which can be afforded by quality control methods.

This is the proper angle from which to view the possibility of introducing quality control to plastic moulding inspection, because the answer to the first question is naturally the one that control charts can only be adequately employed on purely and fully automatic moulding productions. That this is not so will be

shown in later sections, which will deal with the application of control charts and statistical methods of analysis which can advantageously be adopted even in the case of hand-operated injection moulding machines, or manual presses of the kind just discussed

Of course, with such hand-operated machine manufacture a different set of causes of component variation are present than is the case with the automatic injection machine or press. With the former type of machine the main sources of component deviation will be found in respect of the shortcomings of the operator of the machine. These failings will usually be of a casual and random nature comprising such features as: Too long or too short curing period delay in opening the moulds, lack of care in ejecting the finished part or parts, careless insertion of moulding charge, failure to clean the moulds after each "pull" or "shot," neglecting to have the moulds properly closed; in fact, all the odd, erratic, and ill-considered actions or omissions of the operator arising from his lack of skill, experience, knowledge, concentration, observation or intelligence.

Even when such factors influence the quality or accuracy of the moulded article to a marked degree, it is surprising what improvement can be speedily effected by the introduction of adapted forms of quality control, as will be indicated in later articles. This, indeed, is one of the beneficial features of quality control. It is not a rigid system of checking, etc., incapable of being altered or adapted to suit special conditions or circumstances. Even the most difficult set of operating conditions can be confidently tackled, and a scheme of quality control devised for more effectively controlling those conditions.

Reasons for Non-adoption of Quality Control

From the foregoing brief account of the purposes of quality control it will be apparent that it is a system quite capable of being beneficially employed for checking the products of most plastic moulding processes. As far as the author is aware, comparatively few such applications have been made.

The reasons for such a failure are somewhat difficult to understand in view of the now well-established advantages and values which are to be obtained from use of this system. Therefore, before describing the detailed forms of quality control charts and statistical methods, it will serve an extremely useful purpose very briefly to examine the reasons for such poor support and practical adoption of quality control by the plastic moulding industry as a whole. There are a few notable exceptions, of course.

One reason which might account for this lack of support may be due to the belief that because quality control is essentially founded upon the assumption of *continuous machine performance* distinguished by definite production characteristics, and depending as it does upon the inspection evidence and data afforded by relatively small batches of examined components, checked to determine the accuracy or suitability in other respects of the bulk, it could not be relied upon to deal satisfactorily with plastic-moulding production where the human factor often plays a major part in the sequence of operations.

Many moulders also feel that quality control is, perhaps, quite useful for dealing with those types of machined components where the number of variable factors likely to influence the accuracy or quality of the finished article is very small, and thus can be easily controlled.

Contrasting such simple conditions with the very complex ones often surrounding plastic moulding, where very intricate moulds are employed, whose successful usage depends to a large extent upon the skill and care bestowed on them by an operator, the task of controlling quality by means of charts and graphs, it is often averred, is likely to prove cumbrous, elaborate and unreliable.

Another reason is to be found in the assumption on the part of many who

have but the scantiest knowledge of quality control methods and procedures, that the preparation and maintenance of the requisite control charts, etc., is a highly involved and tricky business. Further, the compilation of the charts and their correct interpretation is really the task for an accountant or statistician. It is felt that the charts needed for efficient operation of the scheme are too complex to be used properly by ordinary practical members of the works staff, with the same degree of reliability with which these same people can use a gauge or measuring instrument. Since most moulding shops do not have available accountants and statisticians, so it is said, what is the point in introducing a scheme of inspection which is too complicated to be used to fullest advantage with the personnel at our disposal?

Another reason which may account for the reluctance of plastic moulders to avail themselves of the many advantages afforded by quality control methods of inspection, may be the somewhat widespread impression that the object of the system is *only to dispense* with 100 per cent. gauging and checking operations, by the substitution of complicated charts and methods.

It has to be borne in mind also that very many practical engineers have a strong distrust of paper work of any kind, beyond that of making notes to aid the memory. The author has known of cases where the proposal to adopt quality control in a works has been condemned out of hand, for no better reason than that certain members of the staff felt that too much paper work was involved, and the performance of the additional clerical duties would render members of the works staff concerned less able to get down to their practical work.

One further reason for this failure to adopt quality control is, of course, the natural inertia of many individuals, even those holding positions of leadership, making them ultra cautious in the abandonment of old and tried methods for new untried ones. In the writer's opinion this is one of the most difficult attitudes to overcome, since with all the other objections discussed they can be effectively pinned down and some headway made by judicious argument and discussion. But where there is prejudice and inability even to consider the making of a change, little can be accomplished by argument.

This series of articles must also be regarded not only as informative of the principles and working of quality control applications to plastic moulding, but at the same time a plea for greater study being given to the system by production engineers, who thereby may easily win for themselves some of the valuable advantages possessed by quality control, to the simplifying of production and elimination of some of its worst variable features.

Determining the Production Characteristics

Having now indicated the general underlying principles of quality control, pointing out some of the advantages which may be expected from its application, and, it is hoped, meeting certain objections likely to be raised against its adoption for plastic moulding, we come to a consideration of the basic principles involved in the construction of control charts, together with rules and general procedure governing their operation.

It is advisable to expend a little care and attention on this subject right at the outset of the series, because in discussions from time to time which the author has had with plastic moulding production engineers, who have been favourably inclined to adopt quality control, it has been made plain at a very early stage throughout the talks that the fundamental concepts and ideas upon which quality control is founded are not as well understood as they might be. Many have acquaintance with the general features of the scheme, and realize some of its advantages, but this is hardly sufficient to ensure correct application of the scheme.

This results, of course, in production engineers encountering all sorts of diffi-

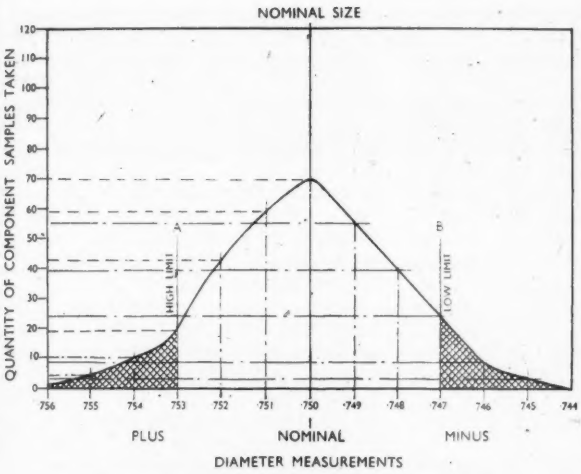

Fig. 1.—Chart illustrating production characteristic for ¾ in. diameter sleeve.

culties and snags when attempting to apply quality control method to a particular moulding operation, arising not because of any inherent defect in the system itself, but purely as a result of the inadequate understanding and knowledge possessed by the initiators of the scheme.

Before control charts can be prepared for recording the data derived from periodical inspections of components, it is essential to determine the production characteristic of the job in question. This production characteristic bears a fundamental relationship and connection with machine or mould, or combination of both, and it will remain substantially unchanged providing no serious alteration occurs in respect of machine, mould, or method of working. The production characteristic is extremely important and valuable as a guide to the production engineer, and is determined in the manner now to be described.

Determination of Production Characteristic for Hypothetical Sample

Taking a hypothetical case comprising only one tolerance dimension for control, this permits the problem being reduced to its simplest proportions for the sake of clarity. The example chosen is, say, a cylindrical sleeve or collar, compression moulded, which has to be closely controlled on its external diameter to hold variations within a tolerance of plus or minus 0.003 in. on a diameter of ¾ in.

In the production of this part variations will undoubtedly occur due to temperature or pressure alternations, unequal shrinkages, mould expansion and contraction, speed or slowness of ejection over respective "pulls," differences in length of cure, variations in the quality of moulding powder and unequal shrinkage rate resulting therefrom. These and many other factors may operate to produce moulded articles having outside diameter variations.

Upon examining a substantial batch of these sleeves (in this case a quantity of 400 is selected, which figure will give a reliable indication of the trend and extent of variations sufficient to plot the "production characteristics") it will be found that only a moderate percentage will measure up exactly to ¾ in. outside diameter. Some will be slightly plus, some slightly minus, but varying only a small amount to bring them within the specified tolerance of plus or minus 0.003 in. Thus a large number of sleeves would lie sufficiently close to the objective limiting tolerances.

Checking the rest of the parts would indicate that a small number of components have an outside diameter varying in size to plus or minus 0.005 in. about the nominal diameter of ¾ in. A very few components would have diameter

variations extending to plus or minus 0.006 about the nominal size.

It is emphasized, of course, that the above data would be obtained from checks upon components manufactured from a press and mould combination which previously had been tested at all points to ensure that every machine and mould member was operating smoothly and efficiently, and that all functions of the moulding set-up would be performed in a proper manner. In ascertaining the production characteristics of a mould set-up before the establishing of control charts can be undertaken, it is essential to derive the characteristic in the most reliable manner, that is, by being sure at the outset that machine, mould and operator are able to function at normal efficiency.

All the above information concerning the diameter variation of the sleeve can be pictorially or graphically represented on a suitable chart of the kind illustrated (Fig. 1). As will be seen the dimensional variations measured over this sample batch of components are plotted and result in a curve which approximates to an inverted "V."

On the horizontal ordinate at the base diameter variations are indicated, this line being graduated each side of the centre line marked "nominal." This centre line, as will be seen, coincides with the exact or nominal diameter of the sleeve, that is 0.750 in. The graduations to the left of this line rise in increments of 0.001 up to 0.756; these represent the plus diameter of the part. Similarly those to the left fall in 0.001 reductions down to 0.744 in.; these coincide with minus variations on part diameter.

On the vertical graduated ordinate at the extreme left of the chart the quantities of sample parts are indicated. The curve of the production characteristic is plotted by first taking the number whose outside diameter is nominal, in this case 70 out of 400 samples. A point is plotted on the vertical centre line opposite this quantity shown on the vertical ordinate and which is indicated in broken lines on the chart. Next the number of components whose diameter is 0.001 is ascertained, and a point plotted on the plus 0.001 vertical line to the left of the centre nominal line. Then those components whose diameter is plus 0.002 are similarly dealt with, and so on until those having the maximum plus variations, for example, 0.006. Precisely the same procedure is then followed for the parts whose diameter varies in the minus direction, the points, of course, for these being denoted to the right-hand side of the nominal centre line.

When all these points have been determined they are joined together to obtain the curve shown which then is the production characteristic of this job. Two vertical lines A and B are marked on the chart to represent the plus and minus limits allowed on the job. These are drawn until each intersects the curve, and the space between represents the average percentage of moulding which may be expected from a normal production run which will be within the dimensional limits specified. The shaded portions at each side of the curve represent the quantity of parts produced outside the specified tolerances, thus indicating the ratio of defective or scrap which can normally be expected.

The angular fall away portions of the V-shaped curve thus plotted will represent the increasing departure of the components from the aimed-at size.

This is an extremely important graph revealing a number of interesting points associated with this particular production problem, which should be fully assimilated if the remainder of the exposition is to be correctly understood.

In the first place it affords a pictorial guide to the type and frequency of occurrence of the dimensional variations; thus, mould tendency to produce small or large components is reliably indicated.

Secondly, it reveals the extent of those variations, together with the proportional parts falling outside the range of permitted variation. This information will at once show to the production engineer whether it is really possible to produce the job on the existing set-up to the

Leaves from a Moulder's Notebook

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Transfer Moulding—Split Die Problems

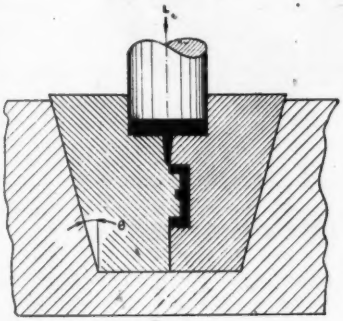

Fig. 1

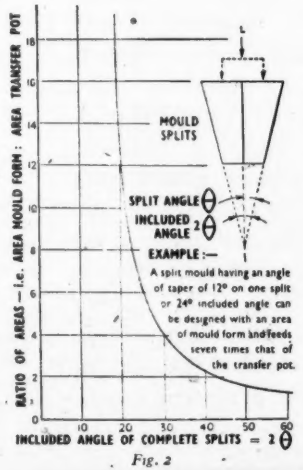

Fig. 2

With transfer moulds having tapered split dies with separate or integral transfer chambers or pots (*see* Fig. 1), lifting of the dies from the bolsters can occur if (*a*) the taper is too great, or (*b*) the projected area of the mould form and feeds is too large. The formula below can prove a useful guide in determining the maximum taper of splits and/or the maximum projected area of mould form and feeds which can be permitted with a given mould.

Where L = *total transfer force*

P = *transfer pressure in tons per sq. in.*

A = *allowable projected area of mould form and feeds.*

μ = .14 (*coefficient of friction*)

θ = *angle of split taper wall*

the formula is $$A = \frac{L}{2P\,(\mu \cos\theta - \sin\theta)}$$

(*The minus characteristic of the answer can be ignored.*)

It can be seen that any increase in θ, the angle of split, will effect a reduction in A, the allowable area of the mould form, whilst a reduction in P, transfer pressure, with respect to L, the transfer force (which reduction can only be effected by increasing the diameter of the pot) will increase the allowable area of mould form. A warning is given that to reduce θ below 10° may cause a tendency for the splits to bind whilst a reduction in P (by increasing pot diameter) to below 8 tons per sq. in. may involve increasing the cross section of the feeds. The curve in Fig. 2 is calculated from the formula given.

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various tolerances which are laid down.

Thirdly, it also guides the production engineer as to what to expect in the way of faulty components, or correct ones, if the limits of permissible size variation are reduced. All that is necessary is to draw vertical lines from the horizontal ordinate at the new tolerance desired, on both the plus and minus side. Where these vertical lines intersect the V curve a horizontal line is run across to connect with the vertical ordinate at the left-hand side, at which point can then be read off the quantity of parts which may normally be expected to fall within the new tolerance range.

Fourthly, this curve will be found to remain *constant* in shape over very lengthy periods of normal production from the mould, provided that no unusual alteration is effected in the set up such as, for example, an increase in the length of cure, slowing up of ejection, etc., or other serious difficulties likely drastically to upset the time and values established at the initial check made to ascertain the production characteristic.

This being so (incidentally, as proved by thousands of actual examples), it is at once clear that the evaluation and ascertainment of this V curve is a most valuable clue and guide to the type of operation with which it is related.

By means of this curve there is provided a full and accurate picture of the type of component which will be obtained unless some unprovided for change, or some assignable reason for variation in the moulding procedure is at any point introduced. It can be ascertained at once, for instance, by referring to the curve in the manner intimated under the third point mentioned above, that if an endeavour is made to produce the sleeve to closer tolerances, be they plus or minus 0.002 in. or 0.001 in., there will be moulded a bigger proportion of defectives to the same total batch production.

Thus in this manner it is easily possible to estimate the number and proportion of faulty parts which will result from adhering to any given scale of tolerances. This information alone will often prove of the greatest assistance to the production engineer to determine just how far it is safe for him to proceed with a tightening up of tolerances on a plastic moulded part.

The most important feature about this curve, however, is that one is able to see at a glance the limits to which a produced article can be manufactured with a relative absence of defectives either to the right or left of lines A and B. This set of limits is known as the "natural range of tolerances" applicable to the production activity being engaged.

The great value of this information will be at once apparent in that there is immediately established a set of broad limits covering normal production activities within which variations may be permitted without requiring any corrective action being applied to the mould. Variations lying outside this range, it will at once be known, are not permitted since these demonstrate the accumulation of defective workpieces.

Continuing this investigation in the succeeding articles of this series the author will show how similar curves of production characteristics are derived for components having a number of variable factors which have to be controlled as is the case with most plastic mouldings. It will then be shown how such curves are employed to form the base of proper production control charts, which are then used for checking the results of production at a later stage.

Following this, the question of appropriate sample selection from which to determine the production characteristic will be dealt with; so far only a single sample has been considered as the basis for this important charge.

Later, the various forms of control charts will be considered in detail to illustrate how they may be adapted in various forms for plastic moulding production in order to cover a large number of variables, such as arise with complicated moulds, or hand-operated moulds and machines.

(To be continued.)

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MICROSCOPIC EXAMINATION OF PLASTIC MATERIALS

(*Continued from page 666.*)

facture. In fact, when the whole field of fibres, both natural and synthetic, is surveyed the number of possible materials which could be put to good uses increases to very large proportions.

The author would like to thank Mr. Sparke, of Hindley and Co., Ltd., for assistance so freely given; his thanks are also due to Mr. T. D. Armitage, of the Mycological Department, Printing and Allied Trades Research Association Laboratory.

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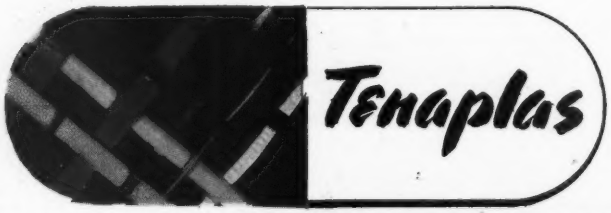

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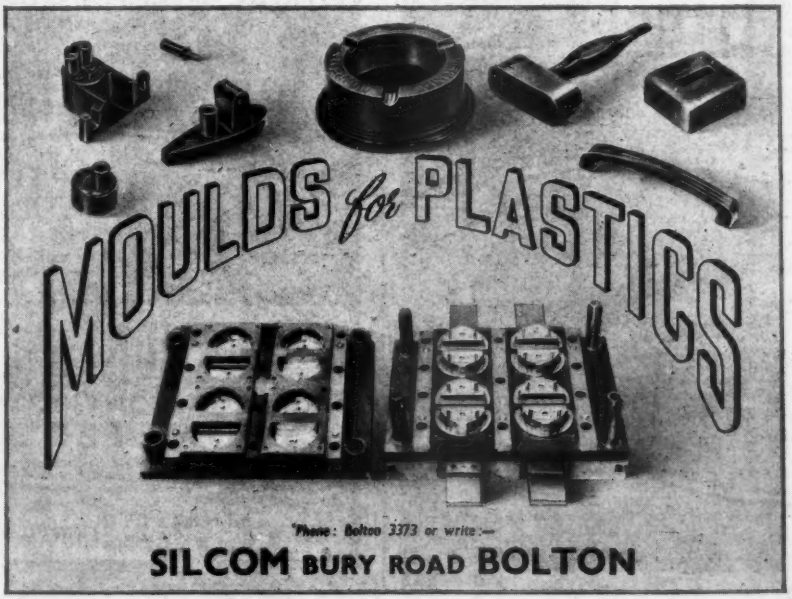

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(LIMITED BY GUARANTEE)

BOWEN PRIZE FUND

The Council of The British Plastics Federation, as administrators of the Bowen (Cables and Plastics) Prize Fund, offer three prizes, to the value of £50 each, for award in June, 1948.

The prizes will be awarded for original scientific contributions in Chemistry, Physics, Engineering or Chemical Engineering of post-graduate standard, and having a bearing on the plastics industry.

Two of the prizes will be open for competition only for employees, of not less than twelve months' service, of member firms of The British Plastics Federation.

One prize will be open to anyone domiciled in Great Britain.

The Council reserves to itself the right to restrict the number of prizes awarded if contributions should not be deemed to be of sufficiently high standard.

Contributions, which must *not* bear the name of the author, should be enclosed in a sealed envelope and forwarded with a covering letter giving the following information :—

Name and address of author.

Name of his employers and length of time he has been employed by them, with a letter from a responsible official representing his employers, giving permission for the author to submit his contribution.

Authors of contributions for the open prize, if not employed by an industrial undertaking, should state their occupation. If authors of contributions for the open prize are employed by member firms of the Federation, they should also submit a letter from their employers giving them permission to submit the contribution.

Contributions should be sent to the General Manager, The British Plastics Federation, 47-48 Piccadilly, London, W.1, so as to reach him not later than first post on Saturday, 24th April, 1948.

It is the desire of the Council of the Federation that all suitable contributions submitted for these prizes shall be published, but it reserves the right to determine, in conjunction with competitors, the method and place of publication.

Additional copies of this advertisement can be had on application to the Federation.

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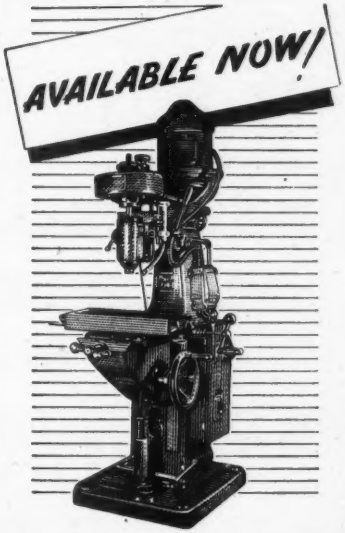

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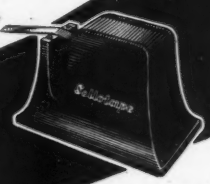

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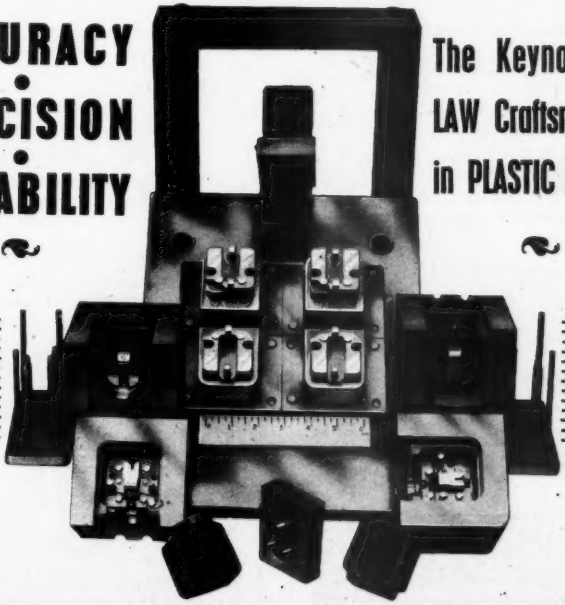

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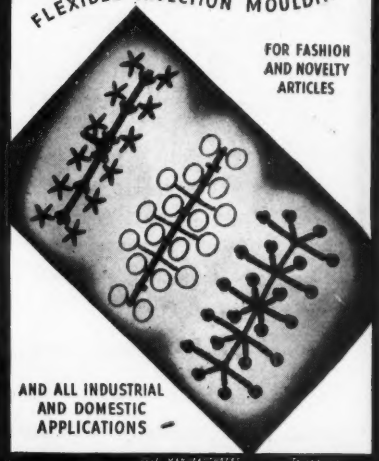

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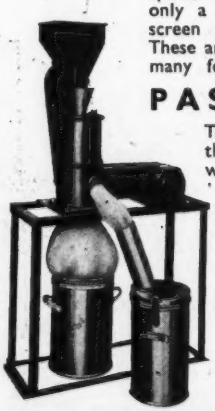

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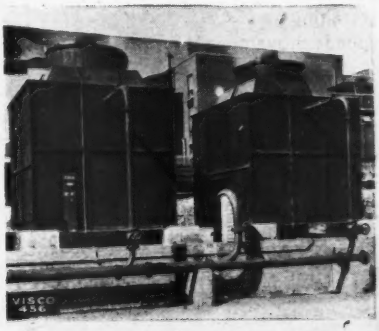

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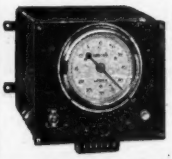
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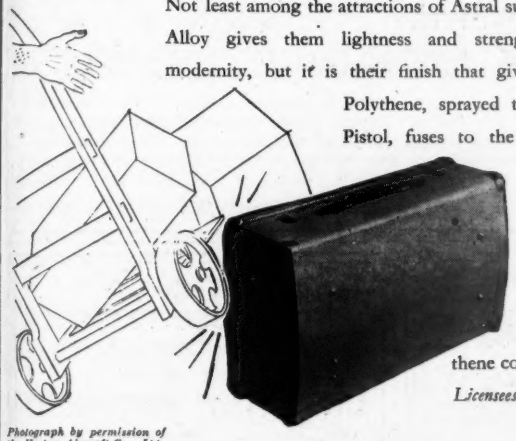

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zzz-408

BUSINESSES, PREMISES, OFFICES, ETC.

Park Lane, Mayfair, W.1. Entire office building, adjacent Dorchester Hotel, total nett area 5,000 sq. ft., central heating, etc., excellent natural light and parking facilities, immediate possession, rental £3,000 p.a. for first-class tenant. No premium. Apply J. Trevor Sons, 58, Grosvenor Street, W.1. (Mayfair 3311.) 127-39

Private plastic manufacturing business, machinery, tools, 1,000 sq. ft. Perspex (colours), 1-16, ⅛, ¼ finished, stock fancy goods, £600 worth, will consider offers £3,000. Box 1514, care of "Plastics." 127-x2691

W. London. Plastic toy manufacturing, established, good connections, weekly turnover £70, net profit £25, large, double-fronted shop, basement, ample scope for expansion; goodwill, fittings, equipment, stock £1,200. National Business Agency, Ltd., 36 Eastcheap, E.C.3. Mansion House 2748. 127-x2413

DESIGN AND DRAWING

Product design and drawing capacity, styling, development and working drawings. H. Woodhouse-Midgley, 34 Kildare Terrace, Bayswater, London, W.2. Bayswater 6080. 132-4014

Production methods, designs and working drawings for equipment and tools for compression, injection- and transfer-moulding, part-time or short term; efficient service by experienced engineers. Omega Designs, 21 Broad Oaks Road, Solihull, near Birmingham. 127-26

Designers of compression, transfer, and plastic blowing moulds, with 25 years' experience, have drawing-office capacity available. Belmont Eng. Works, Belmont Road, Chiswick, W.4. Chi 5407. 127-11

Design and drawing capacity for plastic moulds (injection, compression, transfer) and component design development. Graystone Designs, 35 Winchester Road, Hampstead, N.W.3. Phone, Pri 7420. 127-32

MACHINERY, TOOLS AND PLANT

Two sets hydraulic pumps, by Fielding and Platt, nearly new, horizontal, approximately 200 gallons per minute at 1,750 lb. per sq. in., reduction gear 730 to 120, motor 290 h.p., 400/3/50. Thompson and Son (Millwall), Ltd., Cuba Street, London, E.14. zzz-448

Machinery, Tools and Plant (contd.)

Air Compressor, three-stage, water-cooled, pressures up to 2,000 P.S.I., capacity 4 cubic ft.; F.A.D., direct-drive, 5 h.p., 400 volt., 3 p.h., A.C. motor, complete electrical equipment, automatic starting, bed-plate mounted, excellent working condition, £215. Further particulars, write Box 1559, care of "Plastics." 128-4200

TWO, AS NEW,
HORIZONTAL STEAM-JACKETED MIXERS,
by Gardner and Sons, of Gloucester, having a mild steel trough, 5 ft. by 3 ft. 8 ins. by 4 ft. 4 ins. deep, bottom discharge, with dust cover, with spiral-type blades, driven through gear wheel and pinion from fast and loose pulleys 3 ft. diameter by 7½-in. face with outboard bearing.
REED BROTHERS (ENGINEERING), LTD.,
BEVIS MARKS HOUSE,
LONDON, E.C.3.
129-4264

For disposal, new eight-impression golf peg mould, built for 3-oz. T.M.A. machines. Bargain. Box 1553, care of "Plastics." 127-17

Generators. Diesel-powered A.C. and D.C. generating sets up to 100 kW. A limited number in various sizes available for early delivery. Price and specification on application. Box 1556, care of "Plastics." 127-16

HYDRAULIC AND POWER PRESSES OF SPECIAL INTEREST TO THE PLASTICS INDUSTRY.
Vertical hydraulic extrusion presses, easily adaptable for other work; four-column rising table, 27-in diameter ram, 18-in. stroke, each with variable pressure oil-pumping unit, complete with 3 h.p. A.C. motor. Also vertical screw presses which were used for extrusion work, belt-driven, 12-in. stroke, pressure-controlled by small hydraulic hand pump designed to control pressure, also reeling machines with each.
JAMES N. CONNELL,
PHOENIX AND CLIFTON WORKS,
COATBRIDGE, SCOTLAND.
Phone, Coatbridge 1121-5.
127-3

Generators. Diesel-powered A.C. generators, 440 v., three phase, 50 cycle, 35 kVA, 70 kVA and 110 kVA available for early delivery. Also smaller sizes. Box 1612, care of "Plastics." 127-38

Machinery, Tools and Plant, Wanted

100-ton hydraulic plastic presses (self-contained) required, complete with electrically heated platens. Blackfriars Precision, Ltd., 154-6 Blackfriars Road, London, S.E.1. Phone, Waterloo 4369, 6454. 127-x1919

Hydraulic press, upstroking preferred, tonnage between 75 and 120, any condition, with or without pumping unit. Box 1550, care of "Plastics." 127-18

Wanted, laboratory autoclave, capacity of the order of 1 gallon, made of alkali-resisting material, sufficient to withstand pressures up to 10 atmospheres. Box 1239, care of "Plastics." 128-9

Moulds required for Francis Shaw hand-injection machine for export to hard currency countries. Can be new or second-hand, in good condition. For producing small fancy combs, hairclips, women's buttons and other fancy goods, closures for toothpaste tubes, medicinal and cosmetics containers. Samples and price required in duplicate to Box 1609, care of "Plastics." 127-37

Small laboratory hydraulic press with gauge required, Ibbetson, Stevenage, Herts. 127-47

PRODUCTION CAPACITY AVAILABLE AND WANTED

Pulverizing and grading of raw materials, Dohm, Ltd., 167 Victoria Street, London, S.W.1. zzz-369

Wanted, plastic articles of every description for export and British Isles. Representatives active in all parts. Can place large orders for export. Write N. Gerver, Plastic Dept., 2-10 Mare Street, Hackney, London, E.8. 131-394

Production Capacity Available and Wanted (contd.)

ANGLO SCOTTISH TOOL CO.
TEAM VALLEY, GATESHEAD, 11,
require long-term capacity for the production of HANDLES AND KNOBS FOR SMALL TOOLS AT THE RATE OF SOME THOUSANDS PER WEEK.
BLACK PHENOL POWDER OR OTHER THERMO-SETTING MATERIAL. 127-27

Work wanted, tool room available for all sorts of press tools. Press work, assembling, spraying and all sorts of engineering to your design. Universal Components, Ltd., 19 Sunderland Terrace, W.2. Bay 6776. 131-392

We are able to undertake certain short or long runs of highly specialized medical and technical plastic moulded products. Injection, compression or sheet fabrication. Use our services for the preparation of prototypes. All inquiries strictly confidential. Box 7678, care of "Plastics." zzz-422

Injection moulding capacity available on 3-oz. injection moulding machine for short and long runs. Box 9035, care of "Plastics." zzz-438

Plastic products trade-marked, branded, ornamented, etc., by stamping in gold, silver, pigments; clocks, instruments, Perspex display units. The Superb Stamping Co., 84 Highbury Park, London, N.4. Can 1915. 127-x137

Repetition in Ebonite, Erinoid, etc. Capstan lathe work. Mansell, Temple Street, Rugby. 137-3687

Repetition-capstan in ebonite, cascin and all plastics, etc. Also brass and Rural. Export work preferred. Starr, 110 Mile End Road, E.1. 127-x1076

Specialized welding knowledge and capacity available for P.V.C. extrusions by actual suppliers of raw material. All inquiries treated in strictest confidence and quotations given speedily. Kenrick of Nottingham, 181 Wollaton Street, Nottingham. 127-x2806

Firm invites inquiries for turning, cutting, drilling and assembling of your plastic materials. Box 1600, care of "Plastics." 127-x2854

Embossing and reproducing of wording and designs on plastics, leathers, cards and all materials carried out. L.I.S.T., Ltd., Fernhead Works, Fernhead Road, London, W.9. 129-4201

Kingston Plastics, Ltd., Unity Works, Union Street, Kingston-on-Thames, have all the facilities for cleansing, sorting, grinding, kibbling and reprocessing of thermo-plastic materials. Phone, Kingston 8405. 138-4012

Capacity available, any plastics job. R. D. Rose, Russell Street Chambers, Bingley, Yorks. 127-x3006

"Impossible" moulding propositions invited by pioneer injection moulders with unusually qualified staff and most modern capacity up to 12 oz. Inquiries in strict confidence and without obligation. Box 1241, care of "Plastics." 127-43

Plastic moulding (compresion) capacity available, 30-100-ton presses. Write Box 1670, care of "Plastics." 129-4267

Langley (London), Ltd., offer substantial and regular supplies of laminated plastic S.R.V.P. tubes in round and rectangular sections. Some additional capacity available for processed tubes, but principally for plain tubes in lengths up to 40 ins. Inquiries are invited. Langley (London), Ltd., 161 Borough High Street, London, S.E.1. 127-30

Calendering capacity required for P.V.C. sheeting, 0045-in. to .020-in thickness, 36-in. to 48-in. width. Write Box 1562, care of "Plastics." 127-22

Injection moulding specialists have moulding capacity up to 4 oz. Consultants on all injection moulding problems. Please send inquiries to Box 9761, care of "Plastics." 127-31

RAW MATERIAL AVAILABLE AND WANTED

CUPREX, LTD.,
Stockists of I.C.I. Perspex,
Offer specially:
1/16-in., ⅛-in. and ¼-in. coloured.
Write for stock list and particulars to:—
FINSBURY PAVEMENT HOUSE,
120 MOORGATE,
LONDON, E.C.2. zzz-446

Raw Material Available and Wanted (contd.)

S. R. F. FREED, LTD.,
THE STOCKISTS OF SHEETS, RODS, TUBES, OFF-CUTS AND SCRAP,
OFFER OTHER LINES WHICH CAN BE USED IN COMBINATION WITH PLASTICS,
UTILIZING ANIMAL AND VEGETABLE PRODUCTS.
Such as tortoiseshell, horn, cleaned and prepared cattle bones for industrial purposes, vegetable ivory nuts, porcupine quills, goose and duck feathers, and barrels, etc.
S. R. F. FREED, LTD.,
27b HIGH STREET, SOUTH NORWOOD, S.E.25.
Phones, Livingstone 4042; Sanderstead 2056. zzz-462

MOON AIRCRAFT, LTD.,
SPECIALISTS IN MANIPULATED AND FABRICATED WORK,
OFFICIAL I.C.I. STOCKISTS FOR PERSPEX,
Have available from stock all thicknesses in clear and colour flat sheet cut to customers' sizes.
Inquiries, prices and particulars upon application to
CLIFT WORKS, BOX, WILTS. 132-4266

ALWAYS LARGE STOCKS OF CASEIN
RODS, TUBES AND SHEETS.
PERSPEX
SHEETS UP TO 1 IN. THICK.
CELLULOSE ACETATE.
S. ROSENFELD,
93 ALDERSGATE STREET, E.C.1.
Phone, Clerkenwell 4686. 127-4019

Warerite. Substantial quantity decorative panels, assorted colours and wood grain finishes, for disposal, price 5s. 6d. sq. ft. ex-works for minimum 20 sheet lots. State colours in which interested. Box 1555, care of "Plastics." 127-14

Catalin. Substantial quantities sheet and rod, various colours, price 4s. lb., plus carriage. Send details of requirements to Box 1554, care of "Plastics." 127-15

Ebonite and bakelite always in stock. Phone, Archway 3654. A. E. Goodeve, Ltd., 188a Seven Sisters Road, London, N.7. zzz-445

For sale, P.V.C. scrap. Offers invited. Box 8494, care of "Plastics." zzz-426

Cellulose acetate scrap urgently required; best prices paid. Write Cuprex, Ltd., Finsbury Pavement House, 120 Moorgate, London, E.C.2. Phone, Metro. 9641-5. zzz-424

Urea formaldehyde moulding powder for sale, 15 tons immediate delivery, at 2s. 11d. per lb., carriage paid. Sample of powder on application; also large quantities of phenol formaldehyde at 2s. 6d. per lb., in black, walnut, red and green. Box 513, care of "Plastics." 127-3000

500 Sheets clear 60/000 Plastic, British Celanese Cellustoid, for disposal, as new, interleaved with tissue. Astral Aero Model Co., Dixon Lane Road, Lower Wortley, Leeds, 12. 129-x2855

Perspex and Crinothene, official I.C.I. stockists for North-West area, invite inquiries for flat sheet Perspex, clear and coloured, from 1/16-in. to ½-in. thickness; also official I.C.I. stockists of Crinothene. Plastics (Manchester), Ltd., 11 Whitworth Street, Manchester, 1. Phones, Central 0272 and 1725. zzz-447

Highest prices paid for P.V.C. sheeting. Samples to Dept. A.S.T., Newton Home Products Co., Ltd., 93 Goldsmith Street, Nottingham. 127-x172

Raw Material Available and Wanted (contd.)

Perspex acrylic sheet. Stockists offer good range in clear and coloured. Stock lists available. J. H. Berry (Plastics), Portland Works, Annesley Woodhouse, Notts. East Kirkby 2151. 127-2195

Metal powders and oxides. Quotations and samples on application. Dohm, Ltd., 167 Victoria Street, London, S.W.1. zzz-410

We are now able to supply an adhesive suitable for cementing the Perspex which we supply. Inquiries to Cuprex, Ltd., Finsbury Pavement House, 120 Moorgate, London, E.C.2. zzz-429

For sale, 15 tons P.V.C. black compound (recovered); samples available. Write to Cuprex, Ltd., Finsbury Pavement House, 120 Moorgate, London, E.C.2. zzz-428

Wanted, plastic waste and plastic piece goods. Send particulars, stating quantity and price. Box 6695, care of " Plastics." zzz-400

Perspex off-cuts, clear and coloured, cut to required size, lacloid rods and all forms of scrap plastic material; immediate delivery. Write, Plastic Department, J. E. Hoare, Byton Chambers, Amen Corner, S.W.17. zzz-399

Regular supplies of imported phenolic and urea powders, polystyrene and cellulose acetate injection powders. Inquiries, Box 1211, care of " Plastics." zzz-454

Regular supplies of imported celluloid and cellulose acetate sheets, tubes and rods. Inquiries, Box 1212, care of " Plastics." zzz-455

Paraformaldehyde, three tons available, 1s. 2d. per pound. Box 1237, care of " Plastics." 128-3689

Moulding powders. If you have any redundant stocks for disposal contact us and also give us your inquiries if you are in need of supplies of other powders. Box 9756, care of " Plastics." 128-3736

Scrap. Why not let a well-established firm quote you for cellulose acetate, polystyrene, P.V.C. cuttings and other thermoplastic off-cuts and scrap? Having best use for these materials, highest prices can be paid. Quotations on receipt of representative samples to M. H. Grist (Plastics), Ltd., 82-84 Brighton Road, Surbiton, Surrey. Phone, Elmbridge 4214. zzz-457

Wanted, plastic sheeting in all thicknesses from 1-16-in. to 1-in. Can place large orders for home and export markets. Please submit samples and prices to N. Gerver, 2-10 Mare Street, Hackney, London, E.8. zzz-456

Perspex for sale, new sheets, offcuts, large and small scrap, powders; clear and colours. Box 9024, care of " Plastics." 128-3737

P.V.C. strippings from cables, thoroughly cleaned, black, brown, red yellow, blue, etc. Segregated. Large quantities, 1s. 3d. lb.
John Walton and Co. (Castleside), Ltd., Metalex Works, Gt. Cambridge Road, Enfield. Phone, Enfield 3425. zzz-458

2 mm. clear cellulose acetate sheeting at 5s. per lb. 2 mm. black cellulose acetate sheeting at 4s. per lb. 4 and 5 mm. clear cellulose acetate sheeting at 6s. per lb.
2 mm. paper-covered Perspex acrylic sheeting at 6s. per lb.
3/16 in. paper-covered Perspex acrylic sheeting at 4s. per lb. In cwt. lots or over. Box 1658, care of " Plastics." 127-20

Polystyrene. Moulding powder virgin material for disposal. Delivery immediate ex stock. 10 tons, colours being white, green, black, blue, red. Keen price to clear. Box 1549, care of " Plastics." 127-19

Celluloid sheets, black, 30/000, virgin state, surplus stock to dispose. The Normograph Co., Ltd., 42 Sherrick Green Road, N.W.10. 127-6

Perspex (clear) paper-covered for disposal.
20 sheets, 48 in. by 36 in. by 3/8 in. thick; 32 sheets 36 in. by 24 in. by 3/8 in. thick; 46 sheets, 18 in. by 12 in. by 3/8 in. thick; 22 sheets, 36 in. by 36 in. by 5/16 in. thick.
Hughes Engineering Co. (Leicester), Ltd., Noble Street Works, Leicester. Phone 60376. 127-5

For sale constantly, cut-offs of 1/8 and 1-16-in. natural Holoplast, from 1s. per pound, according to size of pieces. Larks Spraying Process, Monument Hill, Weybridge. 127-34

Plastic boards, 1-16-in., specially treated, highest artistic finish; suitable for panelling, furniture, bath, splashbacks, etc.; plain colours of marble effect, and wood (oak, mahogany, walnut, etc.), sheets 8 by 4 cut to requirements. Prompt deliveries. Larks' Spraying Process, Monument Hill, Weybridge. 127-33

Raw Material Available and Wanted (contd.)

Plastic strips 1 in. and 1 5/8 ins., various colours in stock. Holden and Hitchon, Ltd., 175 Piccadilly, London, W.1. Phone, Regent 4888. 127-35

Quantities of thermo-plastic virgin and reconditioned moulding powders available for home and export. Box 1611, care of " Plastics." 127-36

Polystyrene scrap urgently required; please send samples and offers. Box 1610, care of " Plastics." 127-35

For sale, surplus to requirements, approx. 800 lb. virgin cellulose acetate moulding powder, colour red, 3s. 9d. lb. Apply Box 1551, care of " Plastics." 129-4018

Acetate sheet (clear) for sale, new material, various gauges. Collingridge and Co., Ltd., Riverside Road, Watford. Phone, Watford 5963. 128-4016

For sale, approx. 3 cwt. suntan colour transparent acetate, full size sheets in perfect condition, price 5s lb. D. Bolder, 61 Dancer Road, Richmond, Surrey. 128-4015

Acetate cellulose sheeting wanted to purchase for cash, transparent or coloured up to 30 thou. thick, any size or quantity, send samples with details. Allans, 37 Farringdon Street, London, E.C.4. 132-4013

Perspex sheet, clear and coloured, 1/16 in. to 3/8 in. available. Box M.T., Wydell's Advertising Service, 84 St. Paul's Churchyard, London, E.C.4. 129-4265

Wanted, thermoplastic moulding powders and moulding scraps, all kinds. Offers and samples to Alfa Plastics, Ltd., 20-21 St. Dunstans Hill, E.C.3. 127-42

Polythene. Required by manufacturers, quantity of ivory or natural polythene. Box 1668, care of " Plastics." 127-44

Reground polystyrene wanted in pastel colours, good price paid. Write Box 1587, care of " Plastics." 127-28

Stockist of I.C.I. perspex acrylic resin sheeting make special offer of coloured material for limited period only. Write for details, Box 1561, care of " Plastics." 127-23

11 tons phenol formaldehyde for delivery within 6-8 weeks, can be supplied to manufacturers provided it is used for 100% re-export as made-up commodities. Apply Box 1560, care of " Plastics." 127-21

SITUATIONS VACANT

None of the vacancies in these columns relates to a man between the ages of 18 and 50, inclusive, or a woman between the ages of 18 and 40, inclusive, unless he or she is excepted from the provisions of the Control of Engagement Order, 1947, or the vacancy is for employment excepted from the provisions of that Order.

Draughtsman Engraver required by firm engaged on plastic mould work in Essex; person with experience is offered a permanent progressive and well-paid position. Send fullest details to Box 508, care of " Plastics." 127-3003

Toolmaker required. Experience on plastic mould work essential. Person with experience is offered a permanent, progressive and well-paid position. Send full est details " Seaforth," Watchett Works, Oakhurst Road, Southend. 127-3045

MANAGER WANTED.

Syndicate, setting up a factory in Denmark for plastics on casein-base, seeks a manager.
A competent organizer is required, with technical knowledge of machinery and manufacturing process.
Commence about April, 1948.

PLEASE REPLY TO BOX 5532,
HARLANG AND TOKSVIG A/S,
BREDGADE 36, COPENHAGEN K,
DENMARK.

127-4

Two physical chemists required by plastics manufacturers (South England). Good degrees essential, Ph.D. standard preferred for one position. Modern laboratories, interesting work, five-day week; attractive salaries, plus bonus. Write in strict confidence, giving usual details. Box 1311, care of " Plastics." 127-3733

Wanted, first-class press and mould toolmaker, good opportunity and remuneration. Apply Peter Kenton and Co., Ltd., 47 Whadcoat Street, London, N.4. 127-3688

Situations Vacant (contd.)

Works manager, experienced in calendering and compounding of plastic materials (P.V.C., etc.), to direct and supervise production. Works N.E. Coast. Long-term agreement and good salary. Applications with full particulars of experience, which will be treated in strict confidence. Box 1329, care of "Plastics." 128-3738

Immediately, experienced operators for calendering, compounding, embossing and coating of plastics for N.E. Coast works. Permanent employment and good wages to experienced men. Applications to Box 1330, care of "Plastics." 128-3739

Representatives with chemical and engineering background required by well-established plastics manufacturer, N.E. London area, experience not essential as training period necessary. Full particulars to Box 1351, care of "Plastics." 128-3788

London firm of moulders require the services of a highly qualified man to take complete charge of administration and production. Good income and prospects for the right man. Applications will be treated in strict confidence. Please apply, Box 1585, care of "Plastics." 127-24

Technologist required for the development of a new plastic process. B.Sc. standard preferred but not essential. Applicants must be prepared to work on development of entirely new process which offers excellent future possibilities and opportunity to develop initiative and resorce. Apply, stating salary, age and experience, to Box 201, care of Granthams, Advertising Agents, Reading. 127-8

Instructor required for plastics at boys' club. Phone, Worthing 3765 or write, Warden, Worthing Boys' Club, Ivy Arch Road, Worthing. 127-2

North of England firm of plastic moulders has an opening for post of manager. Applicant must be a capable mould designer. Opening presents a golden opportunity for advancement after proof of ability. House found if needed. Write Box 1582, care of "Plastics." 127-x2807

Firm in Home Counties invites applications from qualified chemists,: preferably (but not necessarily) with some experience in organic or physical chemistry, for research on plastic materials. Permanent position with attractive salary and good prospects. Apply in strict confidence giving usual particulars Box 1552, care of "Plastics." 128-4017

Junior Chemist required for general analysis and control work, salary to commence £350 per annum. Please apply in writing to the Managing Director, Utilex, Ltd., Mill Street, Kingston-on-Thames, Surrey. 127-40

Small Electrical Co. opening plastics section to manufacture own specialized requirements, require man to take charge. Must be capable of starting section and training staff relying on own technical knowledge. Salary according to experience. Wembley district. Write, stating age, experience, salary required, Box 1669, care of "Plastics." 127-45

Warehouse Hand wanted at South Norwood, some knowledge of plastics useful. Reply, stating experience and salary required, to Box 1667, care of "Plastics." 127-46

SITUATIONS WANTED

Engineer administrator; executive and sales experience, seeks suitable post. Box 1464, care of "Plastics." 127-x2568

Plastics. Well-known man seeks position, sales director (capital available), sales manager. Toys, fancy goods, haberdashery. Commencing January, 1948. Box PP.13695, Samson Clarks, 57-61, Mortimer Street, W.1. 127-7

Small team of industrial chemists of standing with acknowledged research qualifications and wide experience prepared to undertake part-time consulting work in plastics and other fields. Write, Box 1614, care of "Plastics." 127-x2915

TIME RECORDERS

Factory time recorders. Service rental. Phone, Hop 2239. Time Recorder Supply and Maintenance Co., 157-159 Borough High Street, S.E.1. 137-3686

MISCELLANEOUS

Extend Your Trade.
Use a Trade Mark. Consult
Trade Mark Protection Society,
12 Church Street, Liverpool. 130-9745

Engraved name plates, scales, dials, etc., supplied. Tickets and Co., Box 2, Silver Street, Leicester. 129-9541

Miscellaneous (contd.)

Huts. Nissen type, 36 ft. by 16 ft. and other sizes; also other industrial buildings suitable for workshops, canteens, site offices, clubs, etc. No licence required. Write, phone or call (open Saturday afternoons). J. Thorn and Sons, Ltd., Box 138, Brampton Road, Bexleyheath, Kent. Phone, Bexleyheath 305. zzz-430

Photography by Behr will show your product at its best. Ask for illustrated list. 44 Temple Fortune Lane, London, N.W.11. Speedwell 4298. zzz-436

Monomarks. Permanent London address. Letters redirected, 5s. p.a, Write, Monomarks, BCM/MONO76, W.C.1. 128-2192

Manufacturers of greeting cards require additional competitive lines for their travellers calling on wholesalers throughout England and Wales. Box 706, care of "Plastics." 127-3246

Calendars, 21-piece perpetual-figure sets, celluloid, for all ornamental calendars.
Tickets and Co., Silver Street, Leicester 129-3734

Perspex Cement, Grade I, available in large or small quantities, clear and coloured. Trade inquiries from Evolite Plastics, Ltd., 325 Latimer Road, London, W.10. Phone, Lad 1879. 138-4011

R. A. Brand and Co., Ltd., inform us that Mr. A. Gravestock, Mr. J. Hayes and Mr. T. Taylor have left for America by Clipper to visit their Associated Co., Milprint Inc., and other paper converting factories, to study modern technique of the production of flexible packaging. 127-41

Packing Cases for Export, etc. Full service, prompt deliveries. F. Rawle and Co., Ltd., 71 Kensington Avenue, London, E.12. Phone, Grangewood 2003. 132-4010

Quantities of clear, semi-matt, eggshell and full gloss lacquers for immediate disposal at reasonable prices. Write, Crosby and Co., Farnham, Surrey. 127-29

Wholesalers with large turnover seek additional non-couponable lines. Only manufacturers interested in and capable of large supplies wanted. Best cash terms. Box 1586, care of "Plastics." 127-25

Quantity Polystyrene cement available for ex-stock delivery. Alan Levin, Ltd., 1 Mayfields, Redditch. 127-12

"Distrene" Polystyrene Solution (in benzene); 100 by 1 pint tins for immediate disposal. Offers to Newchem, Ltd., 183 London Road South, Poynton, Cheshire. 127-9

W. Page and Sons, Ltd.
Cartons, wooden cases, tea chests and other packing materials.
May we remind our many friends that the supply position with regard to packing materials of all kinds is a bad one and is not likely to improve. By virtue of our progressive buying policy we are still able to offer large stocks of new and once-used cartons, tea chests and other packing materials, and invite your inquiries. New corrugated cartons made to your own specification from off-cuts, for which no Board licence is required. Your inquiries will receive our best attention.
The price of tea chests has now been advanced owing to higher cost of collection from the blenders. Large tea chests, 24 by 19 by 19, at 6s. 6d. each, all in perfect condition; small tea chests, 15½ by 15½ by 19½ and 18½ by 16½, at 5s. 6d. each.
Export cases, 18 by 17 by 16, with ¾-in. ends and ⅝-in. sides, bottoms and lids, at 6s. each.
Packing service.
Will you kindly note that as from October 18 we shall be opening our packing warehouse, which is equipped to deal with packing of all kinds, both for the home and export markets. We will receive the goods, pack them in cartons or wooden cases to your specification, and will despatch them in perfect condition to your customers. If this service appeals, we would be pleased to send our representative to discuss the details. We are in a position to supply materials and our experience in this field will save you money on packing costs and will certainly save space in your factory that could be turned over to increased production.
Write or phone. W. Page and Sons, Ltd., 34 Langside Crescent, Southgate, London, N.14. Phone, Palmers Green 5087 and 9916. zzz-463

Manufacturers of building materials who may have supplies available for export in view of the cut in the housing programme are invited to communicate with the advertisers who have specialized for many years in the shipment of building materials to overseas markets. It is advertisers' custom to purchase for own account on an F.O.R. works basis, thus relieving the producer of all shipping and marketing problems. Write Box PB.826, Deacons Advertising, 36 Leadenhall Street, London, E.C.3. 127-x2257

Up-to-date technical data in abridged form wanted for plastics trade handbook. Box 1601, care of "Plastics." 127-x2853

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CATALIN is supplied in rods, sheets, tubes and special profile sections; a wide range of glorious colours and mottles, opaques, translucents and transparents; is free-working; easily machined; has good physical properties; odourless; tasteless; non-inflammable; resistant to alcohol most acids and micro organisms.

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CATAFORM for casting press tools.

Catalin

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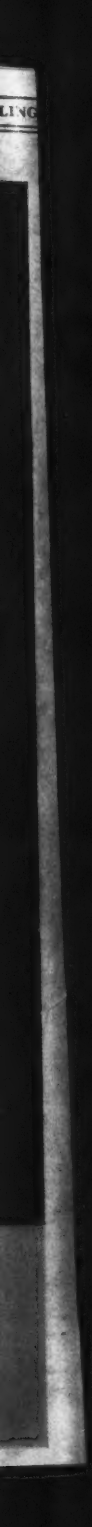
CATALIN LIMITED, WALTHAM ABBEY, ESSEX. *Telephone:* *Waltham Cross* 3341

DECEMBER, 1947. Vol. XI. No. 127 **Plastics** TWO SHILLI